ENGINEERING

THE UNIVERSITY OF MICHIGAN
NOV 11 1959
ENGINEERING LIBRARY

FUSION IN MEASURING
FACE ROUGHNESS

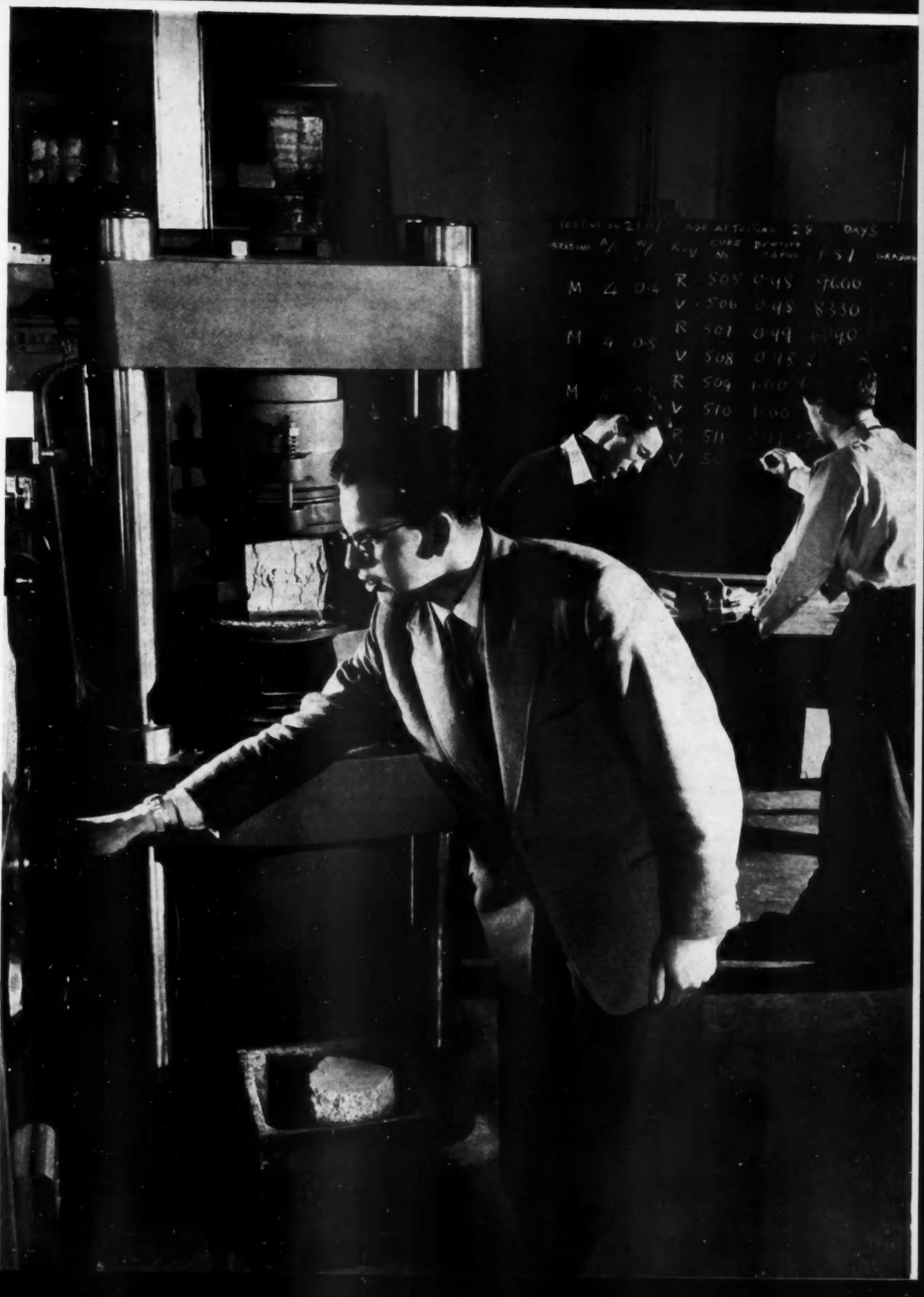
omobile Engineering
ED AND ACCELERATION

CASED STANCHIONS
BS 449

mic Review
ADIAN REACTIONS

THE INFORMATION
ICER INFORM

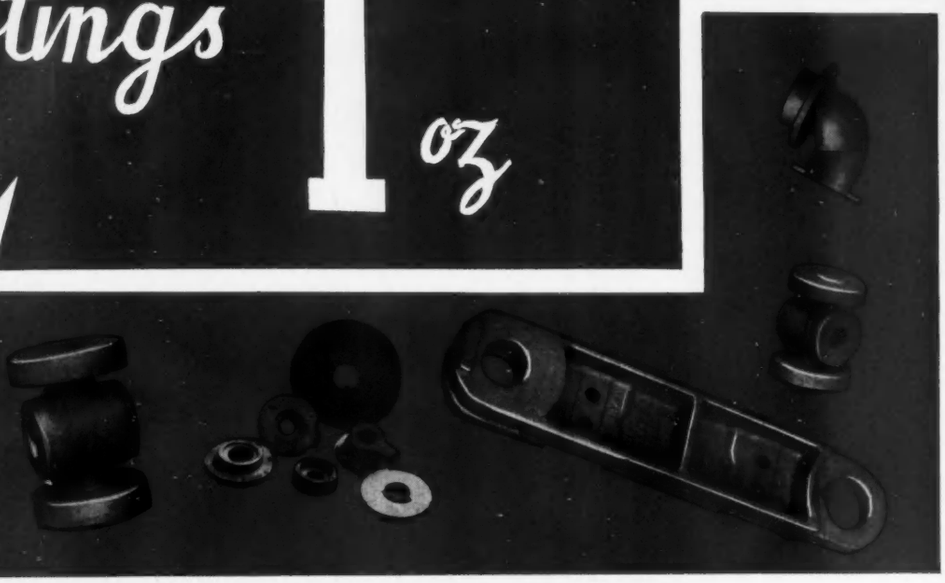
THE UNIVERSITY OF MICHIGAN
NOV 11 1959
ENGINEERING LIBRARY



ing Concrete Cubes

XUM

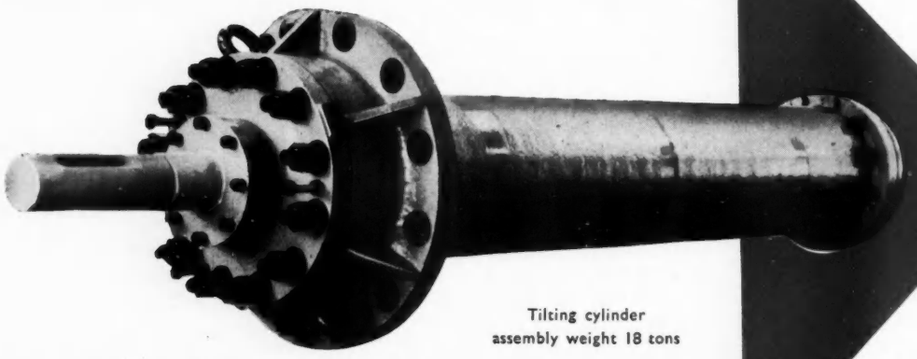
Castings 1 oz



to 20 tons

By the most economical and conventional foundry methods in . . . . .

CARBON
LOW ALLOY
MANGANESE
STAINLESS
WEAR RESISTING
HEAT RESISTING



Tilting cylinder assembly weight 18 tons

HADFIELDS
SHEFFIELD

HADFIELDS LTD., EAST HECLA WORKS, SHEFFIELD

ENGINEERING

Vol. 188 No. 4879 23 October 1959

PUBLISHED EVERY FRIDAY

Contents

365 **Leading Article**
Time to Pick a Winner

366 **Plain Words**

366 **Weekly Survey**

367 **Letters to the Editor**
Axle Fatigue Tests
Axial Elasticity
Gas Cooled Reactors

371 **Meetings and Papers**

372 **Automobile Engineering**
The Desire for Speed and Acceleration

374 **Special Article**
Let the Information Officer Inform

378 **Atomic Review**
Canadian Reactions

381 **Companies in the News**

385 **On the Shelf**

385 **Publications**
Fine Particle Measurement
Labour and Economic Development
Conference on Computers in the Iron and Steel Industry
High Speed Computing Methods and Applications

386 **New Books and Trade Publications**

396 **At Home**
Costly Warmth

368 **New Plant and Equipment**
Mould Dryer, Tube Bender, Gamma Detector, Drill Head, Impregnation Monitor, Shunting Locomotive, Industrial Space Heater, Jig Grinder, Portable Bar-Shears, Continuous Ash Extractor, Hopper Level Switch, Duplex Compressor, Recording Batch Counter, Multi-spindle Drills

373 **The Human Element**

376 **Construction**
Encased Steel Stanchions and BS 449
Weekly Construction News

382 **Research and Development**
Scientific Films Lively and Informative
Wind Tunnels for Automobile Research
Engine Noise, Faster Data Processing, Giant High Vacuum Tank, Nuclear Maser Magnetometer, Slowing Molecular Beams, Automation of Complex Processes, Heat Transfer at Higher Gas Pressures

387 **Metals and Materials**
Packings in Ptfe Tolerate Rough Shafts
Mouldings for Automobiles, Vinyl Coating Resists St. Lawrence, Hot Tapes, Plant Decomposes, Translucent Ceramic, Gallium

389 **Design**
Proteus-Powered Patrol Boat
Versatile Tractor with Digger and Shovel
Design Picture Page
Extensible Hydraulic Link for High Pressures
Self-Adhesive Urethane Foam
Alternator Without Brushes or Commutator

393 **Production**
Confusion in Measuring Surface Roughness

395 **Marketing**

Time to Pick a Winner

WITH the new Government firmly in its place, we can look forward to the resolution of many temporarily suspended issues. When the Galbraith Committee failed to pronounce which of the seven or eight marine reactor proposals was to be adopted for a ship, it was generally considered that the decision had been postponed until after the election. But already it was realised that the parameters and unknowns were too numerous for conclusive comparative analysis; that political considerations were involved; and that ultimately the responsible minister would have to decide.

Essentially the choice lies between some system that is British in origin but untried (at least on the scale necessary for a ship), and some system that has undergone slightly more development, but only in America. The question remains: since the first nuclear ships cannot be economical, and since our purpose in building one must therefore be experience or prestige, why choose a reactor system that cannot be described as British? Prestige comes from combining vessel and reactor; if the reactor is American what remains for us? Everybody knows that we can build a ship.

The most cogent argument in favour of an American-derived design is that if we are to build a small reactor soon, we must choose a system which is immediately practicable. For this reason it is rumoured that the contenders most likely to succeed are two systems with a history of successful development in the United States: the boiling-water reactor and the organic-moderated reactor. Both have been criticised on grounds of low development potential.

But ship and shore have close associations. Britain until now has not developed small reactors for land-based power stations, yet only small reactors have reasonable prospects in the export market. No foreign purchaser is likely to risk his money on a small reactor that has not first been tried at home; but Britain herself has no use for small reactors in power generation. Three ways of escaping from this impasse may be discerned. Build a prototype in this country and write off its cost on subsequent sales abroad. Build a prototype abroad, preferably in the Commonwealth and within reach of a materials-testing reactor and other research facilities, and under special guarantee and conditions of sale. Or thirdly build the prototype in a ship so that it can later be adapted for power application. Thus ideally, the ship reactor should be adaptable for power generation.

Besides the criteria of choice already enumerated, it is necessary to bear in mind the question of our national pattern of nuclear development. Though no small reactor could fit into our power programme, the study of a small reactor might help to solve the problems that face the big-reactor builders. There has been no fundamental change as yet in our reactor policy: initially we shall build advancing forms of large gas-cooled reactor, usually with little or no enrichment, producing power and plutonium; later, in spite of current setbacks, fast reactors will be added, capable of burning the plutonium produced and breeding more. The United Kingdom Atomic Energy Authority are now considering supplementing their present development programme with a second-string small reactor, probably the steam-cooled heavy-water system. In this context, gas (including steam) cooling is likely to be acceptable.

Apart from the steam-cooled system, there is a design for an advanced compact form of Calder Hall reactor, which uses stainless-steel fuel canning, as do the new Generating Board proposals, but not the Authority's Advanced Gas-cooled Reactor. And there is the high-temperature gas-cooled reactor, to be studied by the UKAEA in conjunction with the Europeans under project Dragon. But the latest official British view appears to be that, notwithstanding the prospect of long-term economies from using a high-temperature reactor directly coupled to a gas turbine, this system has no logical place in the British power programme. It is essentially the rival of the fast reactor. On the other hand, it is expected to play a part in the development of other gas-cooled designs; the exigencies of 800° C operation may provide useful information for 600° C development. Alternatively, we might develop both steam-heavy-water and high-temperature-gas systems in conjunction with the Canadians, who have a complementary background and abundant helium—an ideal high-temperature coolant gas.

Two considerations remain. The difficulty with nuclear power is not in thinking up reactor systems, but in finding how to make them work. The Atomic Energy Authority believe that the effort required to make one reactor system practicable is almost universally underestimated and not within the scope of any single industrial concern. Certainly one criterion of choice should be the extent of the resources that the chosen company will be able and prepared to offer.

Finally, we should not forget plutonium. Britain will soon be the biggest plutonium producer in the world. The reactor chosen must be capable of burning it.

Cover Picture.—*To study the effects of varying the cement and water contents of concrete, students in the Cambridge University engineering laboratory make and test batches of cubes.*
(*Nurnberg photograph for* ENGINEERING)

Plain Words

Tell a non-technical friend that he will be able to buy a space-trip ticket within five years and he will believe you, if he trusts your technical know-when. Tell him that within the same period most of the business offices in Britain can have all their mail delivered continuously by conveyor and he will probably doubt you. Why should he be so sceptical, when one is as technically feasible as the other? Because he knows enough of the fact of life to realise that one is practical politics and the other is not.

I find it stimulating to reflect on the enormous possibilities of engineering today. I find it equally depressing to reflect on our failure to reap the full harvest. Where and why do we miss opportunities?

There is a kind of spectrum of research and development effort. At one end are the washing powders and quick coffee preparations—all the things which are sold to the consumer in vast quantities of small packages, and are thus suitable for scientific research and market research. At the other end are the secret projects for military or quasi-military purposes. These projects are developed in a hothouse atmosphere of secret committees which never feel the chill winds of public opinion. There is no opposition to be overcome in the country and precious little in Parliament.

In the middle of the spectrum are the things which struggle along without the benefit of military secrecy or consumer fickleness; roads and water supplies, for example. These go back to Roman times, but for 20th century problems we must find 20th century ideas, using the techniques of this generation. A network of conveyors would be difficult to build in an old city, but it could be incorporated in the new towns. Look at the activities of Greater London and you observe a highly-complex operation in transport and communication which works on a 24 hour cycle. The packed tube trains and the rat-race cars are only too familiar, but what of the delivery of mail by the Post Office and the thousands of messengers darting over London all day long like water beetles on a stream? Would anyone seriously challenge my belief that this job could be done far better by some kind of automatic conveyor system? The difficulties speak for them selves. Are there no men of power who could promote such enterprising projects?

I am forced back to my original recognition of practical politics. There are some things which can be undertaken because they fit in with the economic and political climate, and there are some which cannot because they do not. But perhaps there are undaunted spirits who will bend politics to achieve the impossible.

CAPRICORN

Weekly Survey

Lord Hailsham's Change of Name

In one sense the appointment of Lord Hailsham as Minister for Science could not have been bettered. The former party chairman is of necessity a man who cannot aspire to the political heights. Not since the Duke of Wellington has it been possible to hold the principal reins of government from a seat in the Lords.

Lord Hailsham, whose brilliant promise as Quintin Hogg was always under the shadow of his eventual succession to the title, is not and could not be in the line of possible future Chancellors, Foreign Secretaries or residents at No. 10. This is important in relation to the position of Minister for Science. For it would be easy for a politician of ambition to strive for quick and easily publicised results. Almost for sure this would damage the steady long term work on which scientific progress is based.

If no dramatic hand-outs emerge from Lord Hailsham's office for long into the future, things may be going better than if the announcements come thick and fast.

What if anything, does the new post amount to? As Lord Privy Seal, the new Minister has the same responsibilities that he enjoyed before as the Lord President of the Council, plus that for the atomic energy programme. The overwhelming research spending from the budget goes to military purposes. If this proportion continues then not only large money expenditure but also the direction of much of the best talent will remain in other hands than Lord Hailsham's.

So far the portents, though negative, are good. Lord Hailsham is against a minister presiding over the Council on Scientific Policy. He also does not intend to interfere with the independence of the universities.

One special condition applies, for the time being, to the new position. While it is held by a member of the upper house the appointment in any Honours List of a famous scientist as a Life Peer would bring the minister face to face with an expert armed with the most stimulating inside information.

Output and Productivity Rise

A broadening of the upward trend in industrial activity in Britain is shown by the October replies to the current Federation of British Industries' four-monthly enquiry.

Among the most interesting of the detailed movements are the greater rise in output by the larger firms against that of the smaller and the leading position in the increases established by the engineering industries, particularly vehicles, while building materials and food, drink and tobacco have the lowest improvement.

Fifty-three per cent of the firms questioned by the FBI report increasing output, only 8 per cent a decline. The numbers employed and the hours per man were up more markedly than at the last enquiry, in June. There were a few firms reporting that it is beginning to get harder to find the labour they wanted. Order books are now lengthening and stocks of finished goods falling significantly.

Last February only 20 per cent of the firms replying were working to capacity, now the figure is 50 per cent.

The increasing optimism about the general business situation expressed in 51 per cent of the replies carries over rather patchily to the capital investment field. Thirty-five per cent expect to authorise more spending on plant and machinery but 25 per cent propose spending less. On buildings the situation is slightly worse. Only 24 per cent more, but 35 per cent less.

While the FBI is recording output performance, Ministry of Labour figures reveal a considerable increase over the last 12 months in productivity. On an increase in the number employed of about 0·1 per cent the production index has moved up from 105 to 113-114.

An increase of 310,000 in the number of men working overtime and a drop of 120,000 in those on short time are two of the factors in the calculation that about the same number of workers produced 8 per cent more.

Better HQ for Mechanicals

A contribution from each member of all classes of the Institution of Mechanical Engineers, equal, oddly enough to 7*s* 9*d* for each £1 of the annual contribution, would meet the financial needs of the Institution's building developments, for which an appeal was launched at the annual dinner.

Purchase of the freehold of No. 1 Birdcage Walk and leases on adjoining property made serious inroads into the reserves which are now beginning to be built up again. The project to carry out several much needed improvements in the property on which vacant possession has now been obtained will cost £100,000 and the Council has decided to try to raise this money from members.

The improvements will include a larger library, a new and larger council room (in No. 3 Birdcage Walk), extra staff accommodation, and the enlargement and improvement of the lower meeting hall. A valuable innovation will be the construction of two special rooms in which members will be able to hold personal conferences with other members and friends.

A bequest of £1,000 from Lt.-Col. Mervyn O'Gorman, a member, is the first donation to the fund. In its appeal the Council points that a donation by all the Institution's members of £3 from members and companions, £2 from associate members and associates, and 10*s* from graduates and students would produce the necessary money.

The Finest Fair in the World

The important part played by trade fairs in the promotion of export trade impressed the Federation of British Industries' committee of inquiry into exhibition facilities in the United Kingdom. The committee, whose report was published yesterday, thought that the present trend towards the internationalisation of specialised fairs could continue and perhaps intensify, and that if it did it would be more important than ever that our fairs facilities should match the achievements of our industry.

The FBI committee concluded that there was an urgent need for a new exhibition building in central London with 500,000 sq. ft of ground floor space, and with restaurants, conference rooms, offices and ample unloading yards and car parks. With the purchase of land for a 26 acre scheme and simultaneously carrying out one of the overdue road improvement schemes, the capital cost has been estimated at not less than £10 million. Stepping out of character for a moment, the FBI committee is forced to the conclusion that the capital cost and the anticipated annual deficit in the early years must be met from public funds.

What the central London proposal does not go out to meet is the foreign, perhaps European, business man who wants to fly in, visit the fair, and fly on to his next call. Will a new exhibition hall, for which the deficiencies set out in this report are but the opportunity, be a boon to industry and not the reverse if it is without first class means of access, including helicopter facilties? In West London, where the committee considers adding a third to the two halls

already there, the volume of protest against a helicopter station would be long and sustained.

A possible clue is contained in the committee's summary of evidence where it appears that those representing the internal-combustion engine urge the setting up of a national exhibition centre near London. If for "near" we read "London Airport" then hope emerges. The severe and immensely costly clearance of 26 acres of central London would be a quite different matter near London Airport. There would be a setting for a building both functional and of inspiring design and one rail link could serve fair and airport. On such a site the great British national exhibition would stand astride the trade routes of the world.

Laboratory Laughter

When Sir James Gray, president of the British Association this year, recently suggested that scientists should adopt a more light hearted approach to their work he raised a profound subject. It is fashionable today to measure scientific work by practical results. The taxpayer's money is expended on grants to give him a return for his money and academic distinction goes increasingly to those whose feet are on the ground rather than to those whose heads are in the clouds. This utilitarian worthiness is a product of the age in which we live and it has its dangers.

Sir James Gray was in effect suggesting that science should be fun for those engaged in it, that scientists should be able to laugh at themselves and if necessary in public and that they should not be afraid of showing to the non-scientific world that even the trained mind can make some mistakes. Such an appeal is to ask the scientists to have a sense of balance, humility, confidence and a sense of humour. The world would be poorer if these qualities are too long subjugated to obtaining scientific results which can always be measured by a department's research subvention.

All this is not to decry careful expenditure or to suggest that scientists should be encouraged to spend their time on hare-brained or comic schemes. It is to insist, however, that a sense of balance, a sense of humour and the confidence to be seen to be wrong provides the right background for the brilliant intuition and the elegant solution. Without both these ingredients, scientific work on even so called practical problems becomes in the end second rate.

Road Structures for the 1960's

Mr. Marples, the new Minister of Transport, is very fortunate. He has inherited from his predecessor, Mr. Watkinson, a road programme that has got started and, at long last, a public opinion that will enable the programme to be enlarged. He has also lost the tag of Civil Aviation and so will be able to concentrate more of his attention on the proper division of capital expenditure between the roads and the railways.

The road problem—traffic outgrowing road capacity—was recognised back in the 1930's. Even then plans made to improve conditions, both national and local, were pigeon-holed, occasionally for good reasons. Under pressure from the Road Campaign Council and the like, and with Mr. Wilkinson's lively support, road improvements got underway. To speed the programme faster there must be a great temptation to exhume the once rejected plans, particularly when those plans already possess certificates of worthiness from the Royal Fine Art Commission and when it might be twelve months before new drawings could be passed and work begun.

But if Mr. Marples is fortunate, so are the engineers who have to design, supervise and construct the new motorways, flyovers and underpasses. For Mr. Marples has a background in the building industry and will know that it has not been standing still technically these last 20 years. Prestressed and precast concrete have made great strides, even in the last three years; high tensile steel, universal sections and welding have all improved the economy of steel bridges; more slender lines and longer spans are practicable. Consulting engineers with experience in these fields could quickly revamp the plans to the style of the 1960's.

. . . Plenty of Coal on Top

It has been evident for some time that the coal industry would have to take account of the change which has developed since 1957 in long-term demand. In 1958, when the trade recession masked to some extent the trend of consumption the industry announced that it would close a number of uneconomic pits and limit output. Last December the Coal Board said it could only carry 22 million tons of coal in stock but by the end of August they were over 30 million tons.

In the *Revised Plan for Coal*, published by the National Coal Board (price 3*s* 6*d*), the Coal Board announces that capital expenditure at 1955 prices is expected to be £105 million less than was originally planned for the years 1956 to 1965. This is a substantial cut back but the industry will still have to go to Parliament for an increase of £100 million in its borrowing powers.

As already announced 240 collieries are to be closed by 1965 involving a cut of 11 per cent in man-power and the establishment of a level of output about 200 million tons a year at a high rate of productivity. There is some flexibility in these figures and the cuts will be severe in some areas whatever happens. The new investment and the expansion side of the industry's activities is to be concentrated in the North Eastern Division, including the Yorkshire coalfield, the South Western including South Wales, and the East Midland Division. The brunt of the cuts will be felt in Lancashire and Durham. The scheme quite openly sacrifices low cost open-cast coal for the need to protect employment for the miners. Demand for coal in 1959 is expected to be about 196 million tons including 4 million tons for export. Sir James Bowman, the chairman of the NCB, has again said that the estimates of demand were realistic. So they may be, but they may also be rather optimistic and the full impact of the cuts may be greater before 1965 than the plan outlines.

Big Jets and Bankruptcy

The traffic conference of the International Air Transport Association has failed to reach agreement on a major fares issue, for the second year in succession. Last year the question of jet surcharges split the world's airlines into two camps: this year the proposal for a widespread extension of "economy class" fares, put up by Pan-American, BOAC and BEA, has resulted in substantial differences of opinion.

There appears to be no disagreement on the basic need to reduce fares. In his report to the fifteenth annual meeting of the IATA Sir William Hildred, the Director-General, stated that the market for passenger air transport was "inexhaustible," provided that fares were kept low enough. The volume of passenger capacity coming on to world air routes in the immediate future is very large; by the end of 1959 more than 300 jets will have been delivered, and a further 200 or more will be delivered in the next two years. In 1958, the industry carried a record number of passengers, yet the average load factor was around 60 per cent. The new jets now coming into service each represent the carrying equivalent of three DC-7C's, so that filling the seats can become crucial.

The contention is that price alone will be the determining factor. This opinion is well backed up by the increase in North Atlantic traffic resulting from the introduction of "economy" class fares—more than 222,000 new passengers, since their introduction.

The opposing view, shared by many airlines, is that the financial position of most companies will not at present stand more than marginal reductions.

The position of those faced with such a decision is not enviable; either course could easily lead to bankruptcy. However, the industry has in general committed itself to the hilt in the purchase of the new jets; may it not now be committed—in spite of itself—to grasping the nettle of low fares?

Letters to the Editor

AXLE FATIGUE TESTS

SIR, In the article "Central Laboratory for London Transport" on page 255 of your issue of 25 September, reference is made to a fatigue testing machine capable of testing full size railway car axles, and it is stated that "this machine . . . will be the only one of its kind in Great Britain."

The statement, without further qualification, might be misleading. A testing rig, designed specifically for the purpose of making fatigue tests on full-size railway wagon axles, was constructed at the National Engineering Laboratory at East Kilbride, and has been employed for this purpose for more than eighteen months. In the course of a large programme of tests requested by a British manufacturer of railway axles, about 70 axles have now been fatigue tested to failure. Although no formal publication of the work has yet been made, references to, and brief descriptions of, the test rig have appeared in the technical press, e.g., in a description of the Laboratory's open days, in *Machinery* for 25 June, 1959.

The Laboratory is pleased to have had the opportunity of discussing the technical details of our equipment with the staff of London Transport.

Yours faithfully,
C. E. PHILLIPS,
Head of Division.

Mechanics and Materials Division,
National Engineering Laboratory,
East Kilbride.
12 October, 1959.

AXIAL ELASTICITY

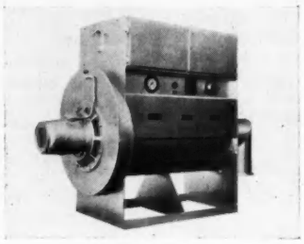
SIR, Mr. D. C. Herbert's letter published on page 195 of your issue of 18 September, respecting my article "Newtonian Theory of Axial Elasticity," contains new ideas and interesting information. The following brief remarks are made in reply.

In compression tests, test pieces of almost any shape and proportions may be used either upright or flat. The various kinds of failure in crushing suggest the stress distributions that the three-dimensional strains lead one to expect. Soft materials interposed between the bearing plates and the ends of the test pieces tend to flow laterally as the load increases. This may cause premature splitting of brittle materials. In tensile tests, the shape and proportions of the test pieces are restricted and the conditions are complicated by the effect of the grips. This aspect is considered in Part 2 of my article and by Professor A. Robertson in a paper on some further test data on effect of grips in tension (Inst.C.E. Selected Engineering Paper No. 28, 1925). The usual failure in tension of brittle materials is normal to the axis, suggesting that the stresses are wholly axial, but the lateral strains indicate that this is probably not so. Tubular test pieces are not considered suitable for investigating three-dimensional stresses or strains.

Steel is by far the most important elastic material of construction, so that references to Lüders's lines, slip bands, etc., as evidence of shear, either before or after yield, do not appear to be out of place. Either the shear stresses are there throughout the greater part of the test or there must be a good reason for their sudden

Continued on page 368

MOULD DRYER
Portable Electric Models



PORTABLE electric mould dryers to Brown Boveri design are now to be made in this country.

The dryers operate by forcing hot air not only over the mould surface but also through the sand itself. Air temperatures 100° to 150° C lower than those of fuel fired stoves are used, but it is claimed that only one-third the quantity of heat is needed and in addition that the time of drying is cut by a half. Very uniform heating is also claimed. Time can also be saved by inserting large cores in the moulds and drying both at once.

The equipment consists of an electric air heater, rated at 25 kW, 70 kW or 140 kW, with two operating temperature ranges, up to 350° C for grey iron and other similar metals, and up to 650° C for steel, a fan and its driving motor, and the associated control gear. The whole is assembled in one unit. The air is heated by being passed at high speed through ceramic tubes containing spiral-wound heating elements. The fan is fitted with a radial impeller and a diffuser, while the motor is completely enclosed. A single switch is used to bring the dryer into operation and to adjust the power in put.

The temperature of the air being fed to the mould is controlled by a pointer-type mercury thermometer fitted with maximum and minimum contacts which switches the elements on and off as required. A manometer measures the static pressure in the mould. The hot air is blown down the casting gate of the covered mould and emerges through the sand; cessation of steam indicates that drying is complete. *Electric Resistance Furnace Company Limited, Netherby, Queens Road, Weybridge, Surrey.*

TUBE BENDER
Thin Wall Sections to Small Radii

NOW available in this country are the Herber motorised machines for bending thin wall tubes and sections to small radii.

The machines are available in two sizes: the RBM 40 for steel tubes up to 1½ in diameter by $\frac{1}{16}$ in thick wall or brass 2 in diameter by $\frac{5}{64}$ in thick, and the RBM 60 for steel up to 2⅜ in diameter and $\frac{1}{16}$ in thick or brass 2¾ in diameter by $\frac{5}{64}$ in thick.

The standard machines are equipped for cold bending on the internal mandrel principle. No filling material is needed. Rolled sections can also be bent in the machines using special tools. The drive from the motor is by V belts to the silent worm gear, which is combined with the positive turning device. The gear runs in an oil bath. Between the motor and the gear is the pedal-operated disc clutch by which the machine is started and stopped.

For clamping the tubes there is a quick-acting locking device. Locking can be carried out with one movement of the hands and since the jaw also swings clear, accurate and efficient bending can be carried out. The mandrel bar and the supporting pressure die form a unit and are operated by a hand lever. It is claimed that this design allows easier insertion of the tubes.

The machine is pedal operated and has an automatic release when the preset bending angle has been reached. Both right and left-hand bends can be made. It is said that the design allows quick and simple tool changing; tools are normally supplied for a radius three times the diameter. *Chamberlain Industries Limited, Staffa Works, Staffa Road, Leyton, London, E10.*

Continuing Letters to the Editor

appearance later on, since there are reasons to believe that this is not so. The lateral strains indicate shear is probably present shortly after the beginning of the test, although the shear strain undoubtedly increases more rapidly beyond the yield point, as also do the lateral strains. Professor W. C. Unwin has stated in his book *Testing Materials of Construction* (Longmans, Green and Company Limited, London, 1910) that Poisson's ratio of steel beyond the yield point is 0·5.

Mr. Herbert's explanation of lateral strain appears to necessitate the introduction of another elastic modulus in terms of the supposed resistance of a solid to change of volume. Alternatively, the hypothetical bulk modulus or the modulus of elastic compressibility might be used. The last, however, is not subject to Hooke's law, as was shown by P. W. Bridgman in his book *The Physics of High Pressure*, which was published in New York about 1935. (There is, therefore, some doubt as to the strict accuracy of the mathematical relationships between the elastic moduli and Poisson's ratio, as found in the classical theory of elasticity.)

Lord Kelvin, in his article on " Elasticity " in the ninth edition of the *Encyclopedia Britannica*, considered that the modulus of compressibility referred to all kinds of materials, including plastic materials. Poisson's ratio of plastic materials is not given in tables of physical properties, such as *Tables of Physical and Chemical Constants*, by G. W. C. Kaye and T. H. Laby (Longmans, Green and Company Limited, London, 1956).

A lateral movement of the particles involving any kind of resistance would result in a change in the strain energy. This, included in the energy equation, would make it substantially the same as equation (1) of the article. Mr. Herbert's interesting descriptions of the tensile splitting of brittle materials in compression add weight to the idea that there must be lateral stresses acting, as assumed.

It is found by experiment that, for small ratios of height/diameter $\left(\frac{h}{d}\right)$ of the test piece, the axial strains $\left(\frac{s}{h}\right)$ are by no means uniform. α and β refer to the assumed indeterminate stress distributions, due probably to the thickness and shape of the test pieces. They are very indirect functions of the height (h), and the differentiation is to this extent an approximation. This should not invalidate the simple method of calculation, found useful to illustrate matters referred to in the text of my article. The two terms of equation (1) become identical for values of h equal to and greater than the critical value, as shown in the calculation. If desired, the result could be found in terms of lateral tension and axial compression.

Mr. Herbert has kindly drawn attention to a correction in the mathematics. The differentiation at the top of page 800 should read $\frac{dF_A}{dh} = -\alpha E A \frac{s}{h^2} + \eta G A \frac{\phi^2}{s} = 0$. The misplacing of the index in the first term is regretted. It is, however, a clerical error, so that the final formula is unaffected. Some of the matters referred to in the letter are considered in greater detail in the article and in the references.

Yours faithfully,

A. N. PROCTER.

Ballymacfrane, Donamon,
Co. Roscommon, Eire.
6 October, 1959.

GAS COOLED REACTORS

SIR, The letter from Mr. Winnett Boyd (ENGNG., 16 Oct., p. 335) draws attention to some interesting features of the high-temperature gas-cooled reactor system which deserve further comment.

The level of radioactivity in the primary gas circuit is the key problem in the design of an all-ceramic core. Three approaches appear to be possible, namely:

1. Continuously purge the fission product gases from the inside of " impermeable grade " graphite fuel containers and pass these through a clean-up circuit. This is the system proposed for the Dragon project.

2. Contain the fuel pellets in " impermeable grade " graphite and provide a by-pass clean-up circuit to reduce the activity in the coolant gas arising from the minute but significant diffusion of fission product gases through the graphite.

3. Abandon the concept of " canning " the fuel and design the complete primary circuit as an hermetically-sealed system. The advantage to be gained in fitting a by-pass clean-up circuit in this case is questionable since the fission products are merely transferred from one circuit to another.

While the first method is theoretically very attractive, the provision of fission product gas take-off imposes some restriction on the design of the fuel element and necessitates the introduction of metallic components and pipework adjacent to the reactor core.

The second alternative is the most conservative but the maximum permissible fuel burnup may then be determined by pressure build-up in the container long before physical damage or reactivity drop set the limit. A further point to note is that zenon poisoning is not eliminated, whereas this is an important advantage of the other two systems.

While the last approach suggested demands considerable reorientation of current reactor design philosophy, practical experience in the design of hermetically-sealed circuits leads us to believe that it is entirely feasible to design and construct a primary coolant circuit to the leak-tightness standards demanded. When one regards the whole picture in true perspective it is clear that the relatively thick steel pressure vessel and boiler tubes operating at modest temperature levels provide a much more reliable form of containment than the flimsy metal fuel cans as used, for example, in the Calder Hall type reactors.

In order to obtain a satisfactory design, however, it is considered essential that the boilers and reactor core should be disposed within a simple, compact pressure shell. This integrated form of layout is a special feature of the de Havilland marine reactor recently submitted to the Admiralty. Further containment vessels can be fitted around the primary pressure vessel and these can conveniently serve a dual function as part of the main biological shield.

The tremendous scope for improvements in reactor performance fully justifies very serious consideration of the active circuit approach. Studies already indicate the real possibility of designing beryllia moderated cores with a working life of 20 years without refuelling and fuel costs of less than 0·2 pence per shaft horsepower hour. With these prospects in store, I am baffled that anyone in the United Kingdom should want to introduce water reactors into the programme at this stage—particularly so in view of the considerable swing towards gas-cooling in the United States. Maybe the grass always seems greener . . .

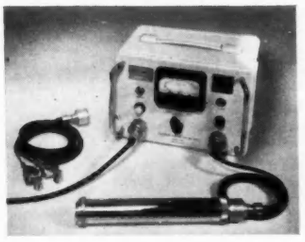
Yours sincerely,

G. E. PREECE,
Nuclear Projects Engineer.

The de Havilland Engine Company Limited,
72 Dean Street, London, W1.
19 October, 1959.

GAMMA DETECTOR

Low Energy Levels



THE PNI 1080 is a portable detector for low energy gamma radiation. It will operate from mains or batteries.

The standard instrument is capable of detecting direct plutonium radiation at 15 c/s per microcurie, and about 0·2 per cent of this value for background radiation. With minor modifications it will also detect the presence of americum, a radioactive substance which will be contained in the plutonium manufactured by reactors in this country, or uranium 235 which also emits low energy gamma rays.

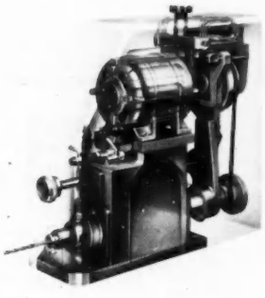
The equipment consists of a probe and an indicator. The probe is a thin thallium-activated sodium iodite scintillator mounted on the end of a multiplier phototube. A chain of resistors is mounted on the inside of the probe in order to provide the correct potential on the dynodes, and a cable matching network ensures optimum signal pulse transfer from the probe to the indicator unit. For hospital use the probe may be enclosed in a polyethylene container.

The indicator unit consists of a pulse amplifier, a preset but adjustable single channel pulse amplitude analyser, a variable and stabilised e.h.t. supply for the photo tube, and a display system. All circuits in the indicator unit use transistors. The probe and indicator are connected by a cable, the maximum length of which may be 6 ft.

The detector is primarily designed for checking plutonium 239 level in the human body, and the sensitivity is such that the maximum permissible body burden of plutonium located at one point gives about five times the background through 1 cm of human tissue. *Plessey Company Limited, Ilford, Essex.*

DRILL HEAD

Air Hydraulic Operation



THE Pacera series 1 drillhead is an air hydraulic unit which will accommodate drills up to $\frac{5}{32}$ in.

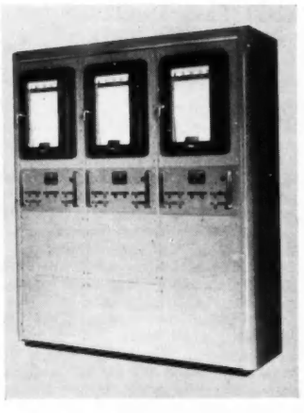
The drill is driven by $\frac{1}{10}$ h.p. motor running at 2,750 r.p.m. The drive pulley gives four spindle speeds in each of two alternative ranges: 2,750, 5,250, 7,750 and 10,240 r.p.m. or 720, 975, 1,440, and 2,750 r.p.m. At a standard air pressure of 80 lb per sq. in, the thrust of the drill spindle is 100 lb. This is suitable for drilling $\frac{5}{32}$ in in aluminium, $\frac{1}{4}$ in in brass or $\frac{3}{32}$ in in mild steel. The spindle nose is solid No. 0 Jacobs taper. The total spindle travel is $1\frac{1}{4}$ in with 1 in of fast approach.

The controls provide for rapid approach, infinitely variable drilling feed, and rapid retraction at a rate of 12 in per sec, the same as for the fast approach. Cam-operated microswitches control the forward and return movements of the drill spindle. Both are adjustable.

For replenishing with oil a priming pump connection is provided with vent valves to release air. The hydraulic system is completely separate from the air system. The feed control is operated by a knurled wheel attached to the main cover by a spring-loaded fitting, setting the rate by means of a needle valve. A standard power pack comprising solenoid-operated main control valve, step-down transformer, emergency port and terminal block is available for use with the drillhead. *W. J. Meddings Limited, Ipswich Road Trading Estate, Slough, Bucks.*

IMPREGNATION MONITOR

For Vacuum Systems



NEW additions to the range of monitor recorders are units for checking the impregnation of cables.

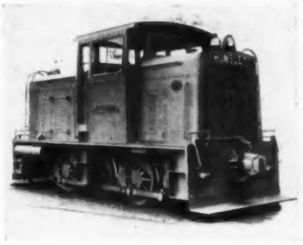
The instruments comprise a four-point servo operated recorder and electronic measuring unit housed in a floor-mounting console. The illustration shows three of these units combined.

The chart records simultaneously the insulation resistance; the capacitance; the temperature; and the vacuum. The test potential for the insulation measurement does not exceed 200V d.c. and is applied continuously to the cable. The variation in resistance is a measure of the occluded moisture. The record of self capacitance is a criterion for air and gas remnants trapped in the insulation and hence of the degree of penetration of the impregnant. A test potential of 30V a.c. is used.

To measure the temperature a thermocouple is used with a thermistor-controlled bridge circuit for ambient temperature compensation. Vacuum measurement is carried out by a hot-wire Pirani gauge using a stabilised electronic circuit. The width of the recording chart is 8 in and speeds of $\frac{1}{4}$ in, $\frac{1}{2}$ in and 1 in per hour can be set with measuring intervals of 20 sec. A synchronous motor supplies the drive. *Addison Electric Company Limited, 10-12 Bosworth Road, London, W10.*

SHUNTING LOCOMOTIVE

Hydraulic Transmission



THE introduction is announced of a Hunslet diesel standard-gauge shunting locomotive with hydraulic transmission.

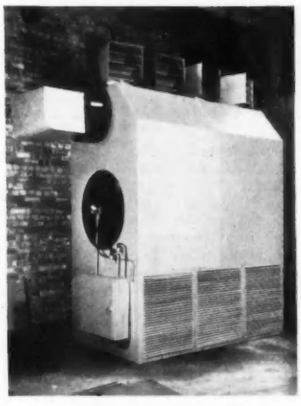
The locomotive is the 0-6-0 type with a weight in working order of 30 tons. It is driven by a Gardner 8L3 engine developing 204 b.h.p. at 1,200 r.p.m. The torque converter is a simple two-stage design giving relatively low torque multiplication but capable of running for long periods at low speeds. A tractive effort on starting of 20,700 lb has been achieved. There are two speed ranges, up to 6 m.p.h. and up to 12 m.p.h.

Good visibility and comfort for the driver are claimed as the central cab gives a flat unobstructed floor. The controls are duplicated on both sides of the cab and are placed to face the shorter end of the locomotive; they are power assisted. A straight air brake acts on all six wheels and additional train braking is possible by a control that cuts out the convertor drive and allows the engine to be used as a brake.

The coupled wheels are 3 ft 9 in in diameter and the wheel base is 9 ft. The overall length is 22 ft and the width 8 ft 3 in. The height is 11 ft 6 in. The maximum axle load in working order is $10\frac{1}{2}$ tons. At maximum speed in first gear the tractive effort is 10,850 lb and at maximum speed in second gear (12 m.p.h.) is 5,450 lb. The minimum radius that the locomotive will traverse with ease is quoted as 120 ft. It is claimed that the smooth starting and adequate braking make the locomotive particularly suitable for wagon weighing, hump shunting and similar duties. *Hunslet Engine Company Limited, 125 Jack Lane, Leeds 10.*

INDUSTRIAL SPACE HEATER

$1\frac{1}{2}$ million Btu per hour



THE Major oil-fired air heater has a capacity of 1,500,000 Btu per hour. It has a guaranteed thermal efficiency of not less than 80 per cent.

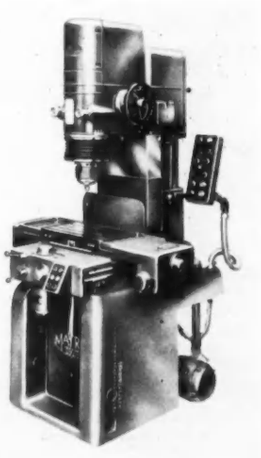
The unit is an addition to the range already made by the firm and works on the same recirculation principle. A pressure jet atomising burner is installed in the combustion chamber and by fitting the fan, motor and pump assembly within the casing a smooth exterior has been produced. The heater is thermostatically controlled.

Economy and safety are covered by automatic devices. There is a dual start to the burner and a damper arrangement integral with the fan adjusts the combustion air setting. A flame-failure device operates by a photoelectric cell. Protection is provided for excessive temperature and for ignition failure. Burner nozzle and exhaust fan relays are fitted, and a selector switch permits the circulation of cool air in summer and acts as the mains switch. A fan air thermostat ensures that the fans circulate air only above a minimum temperature.

The makers claim that the unit has a very low Bacharach smoke number of less than 1, which means it can operate for long periods without cleaning. Maximum consumption is 11 gallons per hour. *Airheating Limited, Murray Street, Paisley.*

JIG GRINDER

For Close Tolerance Work



THE Matrix 56-12-18 jig grinder will machine hardened workpieces to very fine tolerances.

The spindle head has a traverse of 16 in. Vertical movement is powered by a separate motor and a scale indicates the head position. The high frequency spindle has four speeds from 12,000 to 50,000 r.p.m. Constant speed is maintained irrespective of load. The spindle is mounted on a cross slide with a travel of $1\frac{1}{2}$ in controlled by a dial calibrated in 0·0001 in divisions. The collet nose permits the use of diamond impregnated stalks for grinding spindle quills. Maximum diameter hole ground is 5 in, which can be increased by an adaptor plate to 9 in.

A variable speed motor gives infinitely variable quill speeds from 25 to 255 r.p.m. Vertical travel is hand or power operated. Power traverse speed is variable between $10\frac{1}{2}$ and 105 in per minute. The quill can be traversed to the top of its 4 in stroke without disturbing the setting of the traverse stops. The quill can also be rotated by hand for segmental grinding. *Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2.*

PORTABLE BAR SHEARS

Cuts 2⅜ in Rounds

NOW available in this country are the Valdarno portable bar shears illustrated. There are four models with capacities from 1¼ in to 2⅜ in mild steel round bar.

The frame is fabricated from high tensile steel plates to give maximum strength. All gears are cast steel and pinions are nickel chrome forged steel, heat treated and ground.

Power to drive the shears is from a three-phase motor through a V-belt to the fly-wheel and thence by a gear train to the shears. A rolling key clutch is fitted on the camshaft to enable the operator to select either automatic or single action. A friction disc is fitted to each side of the flywheel to act as a safety clutch in case of overload; no shear pin is fitted in consequence. The intermediate gear shaft and the cam shaft turn in antifriction bronze bearings and the flywheel shaft in ball and roller bearings. The driving pinion in the fly-wheel shaft acts as a reduction gear, lessening the wear on the motor and

reducing the speed to suit the operator.

The largest size machine will cut mild steel round bar up to 2⅜ in diameter and square bar up to 2 in. For medium tensile steel these figures are reduced to 2 in and 1⅞ in respectively. With special blades it will cut sheet up to 5½ in by 1 in in mild steel. The blade length is 6 in and the number of strokes per minute maximum is 35. The motor is 4 h.p. *Sharston Engineering Company Limited, Wythenshaw, Manchester, 22.*

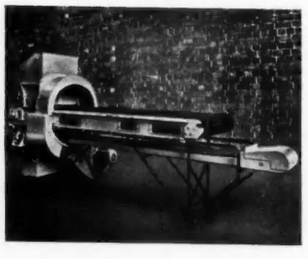
CONTINUOUS ASH EXTRACTOR

For Chain Grate Stokers

AN automatic ash extractor has been developed for use with the Riley model T chain grate stokers.

The extractor is a conveyor type and is designed so that there is very limited wear on the moving parts. The ash is stationary on the apron plate and moves in relation to the conveyor and not in opposition to it as is the case with scraper and drag link models. The conveyor travels at a constant speed of 3½ in per minute and is driven by a separate gear assembly comprising a ½ h.p. geared motor with a reduction of 1,440 : 0·96 r.p.m. and a further gear-train with a 3 : 1 reduction giving a front shaft speed of 0·32 r.p.m. A spring-loaded clutch protects the gear from overload.

A steam-cleaning assembly, which is operated for about 15 sec per week and uses about 1 lb of steam in the process, is incorporated to remove any fine particles of ash that may have penetrated to the interior of the extractor.



The ash box at the front provides for an ash chute to a water trough conveyor. Alternatively a draw plate can be fitted to discharge into a low trolley or pan with runners attached.

The advantage of an automatic extractor is that it eliminates frequent opening of the ash doors and avoids letting in unnecessary cold air. Forced draught fans can be kept running and there is, of course, a great saving of labour. In effect, an ash extractor is the complement of the conveyor for charging the stoker hoppers and forms an additional step to automatic control. *Riley (IC) Products Limited, 19 Woburn Place, London, WC1.*

HOPPER LEVEL SWITCH

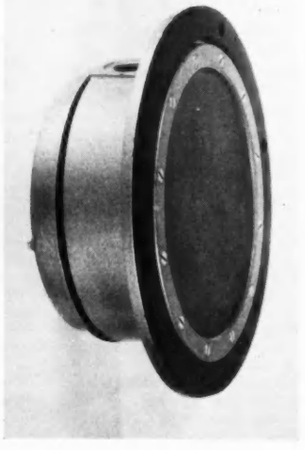
Diaphragm Operated

A NEW and simplified version of the Londex hopper level switch has now been produced.

The switch is designed to operate electrical contacts when bulk materials press against the diaphragm. It can be used as an indicator or as a controller for feeders. It is suitable for use with any free flowing granular material.

It is said that the construction is robust, and dust and damp-proof. The diaphragm is backed by a metal plate so that, though sensitive, the unit can withstand considerable loads. For electrical connection a ¾ in conduit entry is provided. For cases where the hopper is pressurised a ¼ in BSP entry is available for a balancing line.

The switch itself consists of single-pole changeover snap action contacts wired to a three-way terminal block, so that normally open, closed or changeover can be used. Switching capacity is 3A at 440V a.c. or 5A at 250V a.c. The diaphragm measures 6¼ in diameter and



the fixing hole 7½ in. The depth of the unit is 3⅛ in. *Londex Limited, Anerley Works, Anerley Road, London, SE20.*

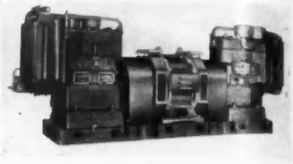
DUPLEX COMPRESSOR

Up to 150 lb per sq. in

NEW to the range of Holman stationary compressors is the duplex unit. It is available in two sizes, producing either 1,050 c.f.m. or 610 c.f.m.

In the larger version, a 230 h.p. motor drives two T60R reciprocating compressors to give 1,050 c.f.m. at 100 lb per sq. in with an operating speed of 720 r.p.m. The smaller has two T36R compressors and gives 610 c.f.m. at 100 lb per sq. in when running at 1,000 r.p.m. Both machines are capable of operation up to 150 lb per sq. in Both the T60R and the T36R are two-stage machines. Unloading pilot valves can be set to work at any predetermined pressure as a safety measure, and an air-blast aftercooler is recommended when cold dry air is required. Automatic equipment can control operation and divide the load among a battery of sets.

The bearings are lubricated by a pump that is driven from the crankshaft. The pump draws oil from the sump through a removable filter and delivers it to the main bearings, big ends and



gudgeon pins. A relief valve protects the system.

The cylinders and valve ports are cooled by means of a closed-circuit system of water cooling which has a low consumption. Cooling of the air from the first stage of compression together with the circulating water is effected by a common balanced fan driven from the compressor crankshaft. This system prevents overcooling and the deposition of moisture in the high-pressure cylinders.

With the two T60R compressors the unit is 192 in long, 43 in wide, 73 in high, and weighs 17,000 lb. The T36R version is 152 in long, 35 in wide, 58 in high, and weighs 10,000 lb. These sizes will vary slightly according to the make of electric motor employed. *Holman Brothers Limited, Camborne, Cornwall.*

RECORDING BATCH COUNTER

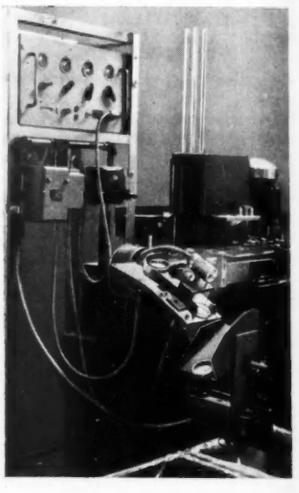
Adaptable Basic Unit

THE batch counter illustrated is designed as a bsic unit for use in a variety of assemblies.

Two cartons or boxes are placed side by side beneath the delivery chute, which consists of an electronically operated bridging device. The items to be counted pass through a light beam.

The output from the counter operates a stepping relay directly the required batch number is reached, and this stepping relay then energises a solenoid which in turn pulls down the bridge thus diverting the flow to the second container.

The solenoid remains energised until the next batch count is reached when the process is repeated, the flow being returned to its original direction. In addition to the control of the diverting bridge the counter also records the total number of batches handled during a production run and thus gives the total output. The unit employs printed circuits which are claimed to make for



great reliability. *Electronic Machine Company Limited, Mayday Road, Thornton Heath, Surrey.*

MULTI-SPINDLE DRILLS

Unit Heads

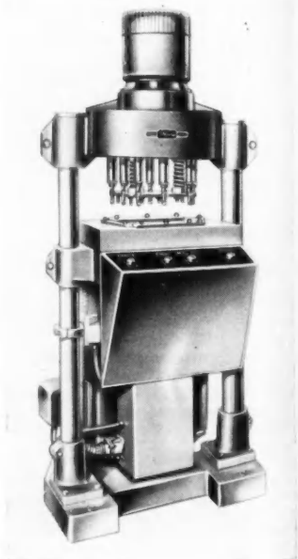
MULTI-SPINDLE drillheads with fixed or adjustable centres are now available in the Pacera range.

These heads can be used with any make of drill and almost any pattern of holes can be obtained. The gearless heads are for drill sizes not exceeding ¼ in and for close spacing of spindles. All drills rotate at the same speed.

Geared fixed centres heads are used where close spacing is not called for and drill sizes are larger than ¼ in. They can run at different speeds to suit the size of each drill or tap.

The universal adjustable centre units for ten spindles take drills up to $\frac{5}{16}$ in. For eight spindle heads the size can be up to ⅜ in. Corresponding speed ratios to the input are 1·25 and 1·4 to 1. Geared adjustable heads are also available.

The hydraulic multihead machine illustrated has a stroke of 4 in and a feed thrust of 5,000 lb. Driving motors up to 7½ h.p. may be fitted. *W. J. Meddings Limited, Ipswich Road Trading Estate, Slough, Bucks.*



MEETINGS AND PAPERS

Association of Supervising Electrical Engineers

CANTERBURY
"Protective Equipment for Industrial Plant," by Dr. W. L. Stern. East Kent Branch. County Hotel, Canterbury. Tues., 27 Oct., 8 p.m.

HANLEY
"Hospital Electrical Installations," by G. Middlemas. Stoke and Crewe Branch. Grand Hotel, Handley. Fri., 30 Oct., 7.30 p.m.

British Computer Society

LEEDS
"Production Planning for a Heavy Machine Shop," by Dr. A. King. Leeds Branch. University Computing Laboratory, Eldon Hall, Woodhouse Lane, Leeds. Wed., 28 Oct., 6.30 p.m.

LIVERPOOL
"Applications of Analogue Computers," by C. C. Ritchie. Liverpool Branch. Mathematical Institute, The University, Liverpool. Thurs., 29 Oct., 6.30 p.m.

British Institution of Radio Engineers

LONDON
Inaugural Meeting of the Radar and Navigational Aids Group. "Radio: Its Impact on Shipping," by Captain J. D. F. Elvish and "A Historical Survey of Radar and Radio Aids to Aircraft Navigation," by Air Marshal Sir Raymund G. Hart. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 28 Oct., 6.30 p.m.*

CARDIFF
Discussion on "Stereophonic Sound and Electrostatic Loudspeakers." South Wales Section. Cardiff College of Advanced Technology, Cardiff. Wed., 28 Oct., 6.30 p.m.

MALVERN
"Superconducting Computer Stores," by Mrs. Lois Roberts. South Midlands Section. Winter Gardens, Malvern. Tues., 27 Oct., 7 p.m.

Helicopter Association

LONDON
Special General Meeting with the Royal Aeronautical Society, 4 Hamilton Place, W1. Thurs., 29 Oct., 6.30 p.m.

Illuminating Engineering Society

LONDON
"Light and Productivity," by A. N. Irens. Federation of British Industries, 21 Tothill Street, SW1. Tues., 27 Oct., 6 p.m. (Tickets required.)

Institute of Marine Engineers

LONDON
Discussion on "Steam versus Diesel Propulsion for Large Ships," opened by L. Greenacre and C. B. Robinson. Thurs., 29 Oct., 5.30 p.m.*

GLASGOW
"The Engineer Surveyor," by A. T. Willens. Junior Lecture. Scottish Section. Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow, C2. Wed., 28 Oct., 7.30 p.m.

LIVERPOOL
"Present and Future Developments in Heavy Forging," by R. C. Benson. Merseyside and North Western Section. Joint Meeting with the Liverpool Engineering Society. 9 The Temple, 24 Dale Street, Liverpool. Wed., 28 Oct., 6 p.m.

Institute of Welding

CHATHAM
"Design for Draughtsmen," by H. B. Merriman. Medway Section. Sun Hotel, Chatham. Wed., 28 Oct., 7.30 p.m.

Institution of Civil Engineers

LONDON
"Some Structural Aspects of the Design of Concrete Pipelines," by N. W. B. Clarke and O. C. Young. Tues., 27 Oct., 5.30 p.m.*

Institution of Electrical Engineers

LONDON
Discussion on "Future Trends in Memory Stores for High-Speed Digital Computers," opened by W. Renwick. Measurement and Control Section. Tues., 27 Oct., 5.30 p.m.* Chairman's Address on "Development of Eurovision," by M. J. L. Pulling. Electronics and Communications Section. Wed., 28 Oct., 5.30 p.m.*

CHESTER
"High-Voltage Direct-Current Transmission, with Special Reference to Cross-Channel Cable," by F. J. Lane. Mersey and North Wales Centre. Town Hall, Chester. Mon., 26 Oct., 6.30 p.m.

GLASGOW
"A New Method for Observing the Phenomena of Commutation," by H. J. H. Sketch, P. A. Shaw and R. J. K. Splatt. South West Scotland Sub-centre. Institution of Engineers and Shipbuilders in Scotland, Royal College of Science and Technology, Glasgow C2. Tues., 27 Oct., 6 p.m.

NEWCASTLE UPON TYNE
"The Provision of Adequate Electrical Installations in Buildings": (*a*) "Multi-Storey Flats and Maisonettes," by C. A. Belcher; and (*b*) "Commercial Buildings," by E. E. Jacobi. North Eastern Centre. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 26 Oct., 6.15 p.m.

SPALDING
"Electrical Floor Warming," by J. W. Moule and W. M. Stevenson. East Midland Centre. East Midlands Electricity Board's Service Centre, Spalding. Thurs., 29 Oct., 7.30 p.m.

Institution of Engineering Designers

BIRMINGHAM
Films on "Lubrication." Midlands Branch. Queen's Hotel, Birmingham. Wed., 4 Nov., 7 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Research on Steel and Aluminium Hatchway Beams," by M. N. Parker, K. V. Taylor and J. A. Ross. Tues., 3 Nov., 6.30 p.m.

Institution of Heating and Ventilating Engineers

LONDON
"Cooling Coil Problems," by L. C. Bull. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Thurs., 5 Nov., 6 p.m.*

BIRMINGHAM
"Characteristics and Sizes of Automatic Control Valves," by L. B. Rothwell. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham. Tues., 27 Oct., 6.30 p.m.

GLASGOW
"The Firing of Heavy Oil," by L. H. W. Savage. Scottish Branch. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C2. Tues., 27 Oct., 7 p.m.

MANCHESTER
Presidential Address on "A Variety of Engineering Experiences," by H. C. Jamieson. Manchester Branch. Engineers' Club, Albert Square, Manchester. Fri., 30 Oct., 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Engineering Challenges to American Automotive and Petroleum Research," by Leonard Raymond. Automobile Division. Tues., 27 Oct., 6 p.m.*
"Strength of Thick Cylinders Subjected to Repeated Internal Pressure," by Professor J. L. M. Morrison, Professor B. Crossland and Dr. J. S. C. Parry. Meeting in conjunction with the Applied Mechanics Group. Wed., 28 Oct., 6 p.m.*

BRISTOL
Repetition of an Address on "Some Problems We Meet," by L. H. Dawtrey, Chairman of the Automobile Division. Western AD Centre. Royal Hotel, Bristol. Thurs., 29 Oct., 6.45 p.m.

KILMARNOCK
Repetition of the James Clayton Lecture on "The Hydraulic Turbine in Evolution," by P. Danel. Scottish Branch. Dick Institute, Kilmarnock. Wed., 4 Nov., 7.30 p.m.

SHEFFIELD
"Industrial Applications of Oil Hydraulics," by F. B. Levetus. Yorkshire Branch. The University, St. George's Square, Sheffield. Wed., 28 Oct., 6.30 p.m.

Institution of Plant Engineers

LONDON
"Constructional Problems Encountered in the Kariba Dam Hydroelectric Project," by T. A. L. Paton. Royal Society of Arts, John Adam Street, Adelphi, WC2. Tues., 3 Nov., 7 p.m.*

CARDIFF
"Properties of Molybdenum Disulphide and Its Use as Plant Engineering Material," by H. Peter Jost. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 27 Oct., 7.30 p.m.

LEEDS
"Alternating-Current Motors and Their Application," by F. T. Bartho. West and East Yorkshire Branch. Houldsworth School of Applied Science, The University, Leeds. Mon., 26 Oct., 7.30 p.m.

SHEFFIELD
"Lifting Tackle," by G. E. Simm, Junr. Sheffield Branch. Grand Hotel, Sheffield. Thurs., 29 Oct., 7.30 p.m.

Institution of Production Engineers

LINCOLN
"Work Measurement and Its Uses for Management," by W. Hewett. Lincoln Section. Ruston Club, Lincoln. Thurs., 29 Oct., 7.30 p.m.

MANCHESTER
"Applications of Hydro-Pneumatic Circuits," by J. M. Kenworth. Manchester College of Science and Technology, Sackville Street, Manchester. Mon., 26 Oct., 7.15 p.m.

SHREWSBURY
"Production in Western Germany," by A. C. Turner. Shrewsbury Section. Shrewsbury Technical College, Shrewsbury. Wed., 28 Oct., 7.30 p.m.

Institution of Structural Engineers

BELFAST
"Extensions to Constructional Shop: 170 ft and Other Long Spans," by F. R. Bullen. Northern Ireland Branch. Civil Engineering Department, Queen's University, Belfast. Tues., 3 Nov., 6.30 p.m.

CARDIFF
Chairman's Address on "The Structural Aspect of Pipe Problems," by C. D. C. Braine. Wales and Monmouthshire Branch. South Wales Institute of Engineers, Park Place, Cardiff. Thurs., 29 Oct., 6.30 p.m.

Junior Institution of Engineers

LONDON
"Planning a Computer Job," by M. G. Ferrand. Fri., 30 Oct., 7 p.m.*

BIRMINGHAM
Debate: "It is the Opinion of This Meeting that Automation is Undesirable." Midland Section. James Watt Memorial Institute, Great Charles Street, Birmingham. Wed., 4 Nov., 7 p.m.

Liverpool Engineering Society

LIVERPOOL
"Present and Future Developments in Heavy Forging," by R. C. Benson. Wed., 28 Oct., 6 p.m.

Newcomen Society

LONDON
"Joshua Gilpin, an American Manufacturer in England and Wales, 1795-1801," by Dr. Harold B. Hancock and Dr. Norman B. Wilkinson. Wed., 4 Nov., 5.30 p.m.

Royal Aeronautical Society

LONDON
"Aircraft Fatigue: A Survey of Current Thought," by R. J. Atkinson. Church House, Westminster, SW1. Tues., 27 Oct., 7 p.m.
Special General Meeting of the Society with the Helicopter Association of Great Britain. 4 Hamilton Place, W1. Thurs., 29 Oct., 6.30 p.m.
Inaugural Meeting of the Man Powered Aircraft Group. Résumé of the "Theory and Practice." Short talks will be delivered by H. B. Irving, Dr. D. R. Wilkie, T. R. F. Nonweiler and B. S. Shenstone. 4 Hamilton Place, W1. Fri., 30 Oct., 7 p.m.

Royal Meteorological Society

EDINBURGH
"Progress in Numerical Weather Prediction," by E. Knighting. Scottish Centre. Department of Natural Philosophy, Drummond Street, Edinburgh. Fri., 30 Oct., 5 p.m.*

Royal Society

LONDON
Various short papers. Thurs., 5 Nov., 4.30 p.m.*

Royal Statistical Society

SHEFFIELD
"Experiments in Telepathy," by Dr. S. G. Soal. Sheffield Group. Grand Hotel, Sheffield. Thurs., 29 Oct., 7 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Uses of Radio-Tracers and Autoradiography in Surface Studies and Metallography," by Dr. G. T. Rodgers. Joint Meeting with the Sheffield Section of the Royal Institute of Chemistry. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 27 Oct., 7 p.m.
"Modern Developments in the Theory of Brittle Fracture," by Dr. A. A. Wells. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 3 Nov., 7 p.m.

Society of Chemical Industry

NOTTINGHAM
"Corrosion Factors Affecting the Choice of Stainless Steels for Chemical Plant," by H. T. Shirley. Joint Meeting of the Corrosion Group with the Nottingham Section. Gas Board's Showrooms, Shakespeare Street, Nottingham. Thurs., 5 Nov., 7.30 p.m.

Society of Engineers

LONDON
"The Dissemination of Technical Information, with Particular Reference to the Aircraft Industry," by K. A. Steel. Geological Society, Piccadilly, W1. Mon., 2 Nov., 5.30 p.m.*

Society of Instrument Technology

LONDON
"Modern Developments in Optical Instruments," by J. H. Bach and G. E. Fishter. Manson House, 26 Portland Place, W1. Tues., 27 Oct., 7 p.m.*

CARDIFF
"Control Systems as Applied to Railway Signalling," by J. C. Kubale. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 28 Oct., 6.45 p.m.

CHELTENHAM
"Satellite Instrumentation," by S. J. Collins. Cheltenham Section. Belle Vue Hotel, Cheltenham. Tues., 3 Nov., 7.30 p.m.

CHESTER
"Industrial Hazards of Computers," by R. H. Tizard. Chester Section. Offices of the English Speaking Union, Stanley Palace, Watergate Street, Chester. Thurs., 29 Oct., 7 p.m.

GLASGOW
"Instrumentation of Hunterston Nuclear Generating Station," by T. M. Dowall. Scottish Section. Building Centre, 425 Sauchiehall Street, Glasgow. Fri., 30 Oct., 7.15 p.m

GRANGEMOUTH
"Electrode Problems in Plant pH Measurement," by Dr. G. Mattock. Grangemouth Section. Ellwyn Restaurant, Newlands Road, Grangemouth. Thurs., 29 Oct., 7 p.m.

SHEFFIELD
Discussion on "Instruments in Machine Tool Control." South Yorkshire Section. The University, St. George's Square, Sheffield. Wed., 4 Nov., 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor at least three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 5927)
British Computer Society, Finsbury Court, Finsbury Pavement, London, EC2. (MONarch 6252)
British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Helicopter Association of Great Britain, 4 The Sanctuary, London, SW1. (ABBey 5160)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Welding, 54 Princes Gate, Exhibition Road, London, SW7. (KNIghtsbridge 8556)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool 2. (Central 3717)
Newcomen Society, Science Museum, Exhibition Road, London, SW7. (KENsington 1793)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, SW7. (KENsington 0730)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335)
Royal Statistical Society, 21 Bentinck Street, London, W1. (WELbeck 7638)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Chemical Industry, 14 Belgrave Square, London, SW1. (BELgravia 3681)
Society of Engineers, Abbey House, Victoria Street, London, SW1. (ABBey 7244)
Society of Instrument Technology, 20 Queen Anne Street, London W1. (LANgham 4251)

The Desire for Speed and Acceleration

The long established demand for fuel economy has begun to lose ground to the somewhat latent desire of many motorists for snappy acceleration and high cruising speed. In Britain, Europe and the United States, engineering developments are now emerging to meet this new market trend.

By Gordon Wilkins

Although the publicity horsepower race is over in the United States, and manufacturers are showing much more interest in fuel economy, there is no sign of a check to the trend towards quicker acceleration and higher cruising speeds among European cars. Ministry of Transport investigations indicate that cruising speeds on British roads are rising at the rate of about 1 m.p.h. per annum, but they are still substantially below the average recorded in continental countries and a further rise may be expected with the coming of motorways and further improvement of trunk roads.

The British Motor Corporation six-cylinder engine and the Humber Super Snipe have all gone up to 2·9 litres and the new V8 takes Rolls-Royce and Bentley up to 6·2. The MGA sports version of the BMC B-type unit has been taken up to 1,589 c.c. by siamesing the bores and a similar modification in Australia has taken the engine for the locally-built version of the Austin A55 up to 1,620 c.c., raising output from 50 to 55 b.h.p., a change which might well find a place ultimately in British production. The 3·4 Jaguar is now offered with the 3·8-litre engine and at least two other popular cars are scheduled to appear with large engines in the coming months.

In Italy, the Fiat 1800 has replaced the 1400, and in Germany small cars like the BMW 700, Goggomobil Isar 700 and NSU Prince are replacing the miniatures. All have twin-cylinder air-cooled four-stroke engines, the once-popular two-stroke having shown disappointingly heavy fuel consumption under prolonged full-throttle running. The rapid increase in sales of performance kits emphasises that many people are willing to pay a premium for extra performance from popular closed cars. Continental manufacturers have long catered for this market with cars like the T.I. Alfa Giulietta, T.S. Borgward Isabella and Dauphine Gordini. The twin-carburettor M.G. Magnette and Riley 4/68 meet the same need here and a recent innovation is a Triumph Herald saloon with the twin-carburettor engine and high axle ratio previously reserved for the coupé. After enlarging their Hillman Minx engine, Rootes have now produced a high-performance version for the Sunbeam Alpine and Rapier with new four-port head in aluminium giving a 9·2 to 1 compression ratio, stiffened block casting with ribs inside the crankcase and crankshaft in En 16 C (U) instead of En 9.

An engine which offers obvious possibilities of enlargement is the very over-square Ford Anglia (80·96 mm × 48·4 MM). Indeed the proportions are such that it seems a reasonable guess that it is intended to form the basis for an additional engine of about 1,500 c.c. using the same bores and production tooling at some future date. It is notable for its shell-moulded semi-steel crankshaft, fully machined combustion chambers, composite exhaust valves with DTD 49B heads welded on to En 180 stems, and the eccentric-lobe oil pump mounted externally in the light-alloy filter housing.

The Anglia also uses a four-speed gearbox for the first time on a British Ford but, as on most British gearboxes, there is no synchromesh on first gear. Continental manufacturers are increasingly adopting synchromesh for first gear, an interesting example being the four-speed box of the 700 c.c. Goggomobil, which has the Porsche servo ring synchromesh for first and second gears mounted on the layshaft, and those for third and top more conventionally on the main shaft. The Porsche synchromesh has been adopted by the BMC for all three speeds in the box on their new six-cylinder cars but the practice has not yet spread to the smaller cars.

This is probably the result of producing cars in a country which has very congested roads but no high mountains. The conditions put a premium on good top-gear performance, neglecting the condition where first gear has to be taken when negotiating a mountain hairpin at high altitude with a holiday load. Though it might have been thought that the big annual pilgrimage to Devon and Cornwall, with the existence of freak gradients like Porlock, would have supplied a corrective.

The existence of two overdrives in England has avoided the need to gear for particularly low cruising revolutions in top gear on British cars, and even on small cars where overdrives are excluded by cost, our cars have tended to be geared for higher engine speeds than their continental competitors, but things are improving. The Ford Anglia is a good example, and the Miniminor is better than most, despite its 10 in wheels as the accompanying table shows.

M.p.h. at 1,000 r.p.m. in Top Gear

BMC Miniminor	14·85	Triumph Herald ..	13·5
Fiat 600	12·8	Volkswagen ..	20·19
NSU Prince ..	13·67	Hillman Minx ..	15·9
Renault Dauphine	14·41	Borgward Isabella	17·39
Austin A55/Morris Oxford ..	15·6	Peugeot 403 .. Vauxhall Victor ..	16·77 16·46

Comparisons with the Volkswagen, Dauphine, and Fiat 600 show that the Miniminor has better top gear acceleration throughout the range, but also achieves a better steady-speed fuel consumption.

The need to improve fuel consumption at higher cruising speeds without the expense of an overdrive will lead to higher gearing and to revision of body shapes. The experiments which led to the new shape for the Ford Anglia have already been referred to in these pages.

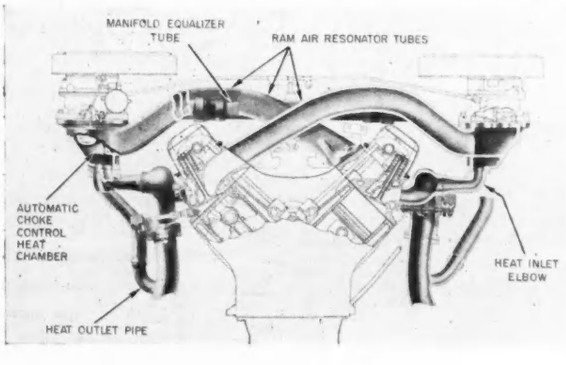
Experiments with an aerodynamically designed Zagato body (right) compared with the notched-back body (left) have shown that the rear body shape does not substantially affect top speed.

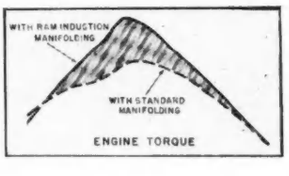
The impression that the front is much more important than the rear on bodies which cannot in any case approach closely to a true streamlined shape receives support from experiments made by Abarth with the new notched-back body developed for his 850 sports coupé by Allemano. This car was first tried out with the 750 engine and achieved exactly the same maximum speed as the coupé by Zagato using the same engine, in which every effort had been made to produce a low-drag form.

Chrysler are presenting a remarkable new ram induction system as an optional extra on V8 engines in Chrysler, Plymouth, Dodge, De Soto and the new Dart range. They have been using motor racing as a means of gaining experience and in 1952 obtained 447 b.h.p. from a 5,424 c.c. V8 developed from a touring car unit, with tuned induction pipes and Hilborn port injection. Chevrolet have also used ram induction on some of their injection engines.

The new Chrysler system is designed to increase torque by about 10 per cent in the passing range from 1,800 to 3,600 r.p.m. It employs a very complex casting comprising eight 30 in inlet pipes which cross over above the engine. Low down on each side of the engine is a four-choke carburettor above an exhaust-heated hotspot, feeding the four cylinders on the opposite side. The torque curve peaks fairly sharply at 2,800 r.p.m. but it remains well above the curve given by the same engine with single four-choke carburettor and normal mainfolds over most of the operating range, and slow running is said to be quite normal.

Chrysler's six-cylinder engines are now tilted at 30° to the vertical and the sump is modified accordingly. This leaves space for an efficient induction system employing six separate long tracts from a single carburettor, although in this case there is no use of pressure waves to increase volumetric efficiency. It also allows room for a less obstructive exhaust system than usual.





Ram induction, a completely new type of air-inlet system developed by Chrysler Engineering, provides torque increases of up to 10 per cent.

Dial D for Democracy

Something like a general election on every topic of national interest, with the poll being counted in seconds instead of hours or days, could be achieved by applying computer technology to the telephone and the radio.

This politician-frightening idea has been worked out by Dr. Vladimir K. Zworykin, who was pioneering in electronics as far back as 1929 and is now director of the medical electronics center of the Rockefeller institute of medical research, New York. Dr. Zworykin proposes a system that would enable every citizen with a telephone, or who cared to walk to a public call box, to vote on any issue being put before him. This return to the "ideal democracy" of the Greek city states, this time without the slaves, might put the pollsters out of business, it would certainly rock the parliamentary boat.

It would work like this. On every telephone would be a tele-voter box. Every voter would be issued with a voting card. Each issue of the day would receive the sort of public airing by the press, television, sound-radio, and posters with which we are familiar. When the polling period came round the voter would insert his card and press either the Yes or No button. (Don't knows would presumably abstain.)

After the poll each telephone exchange could within minutes gather up the results by sending micro-second pulses to the tele-voters, not interfering with the inevitable person-to-person calls speculating on the outcome, and re-setting the voting mechanism at the same time. Normal computer equipment at headquarters would in a brief interval announce the decision. The politicians, with what would indeed now be an electorate breathing down their necks, might take longer deciding what to do about it.

Dr. Zworykin advanced this scheme in the fourth Clerk Maxwell memorial lecture—"The Human Aspect of Engineering Progress"—at the Cavendish Laboratory, Cambridge, during this year's convention of the British Institution of Radio Engineers, who have now published the lecture in full in their September journal.

Maxwell might well have listened to the lecture with particular attention, since he established the theoretical basis for radio communication and delivered his last public lecture on the subject of the telephone.

The gap between bright ideas and their practical application in Britain being what it is years may pass before we get to grips with our own tele-voter (with bedroom extension?). There is another possible application that would accelerate the speed of its acceptance. If the great pools following public realises that there lies close at hand a system whereby it could submit its permutations on the Saturday morning, after seeing the weather and reading the horoscopes, the demand might be overwhelming.

Bound by Tape

The world is full of associations and groups with surprising common interests. The workers of the world unite for some startling common aims and the high rate of technical change today keeps throwing up new ones. Strong silent men will give all their spare moments (and some of the Boss's too) to organising anything from the Territorial Army to snail watching.

One of the latest, with a pronounced flavour of technical fashion, is the British Recording Club which has now absorbed, by agreement we are told, the British Tape Recording Society. This makes the BRC the largest of its kind in the world with direct links with 36 countries. There are said to be 400,000 tape recorder users in Britain and many of these are not concerned with home uses for the machines but with applications in hospitals, machine tools, research and education. The club exists in part to exchange information on an international basis.

The movement also has a magazine. The journal of the BRC, *The Amateur Tape Recording Magazine*, now has a circulation of 25,000. A movement of this size bids to be as widespread as amateur radio. Like weather recording it is an interesting example of group enthusiasm and loyalty based on a technical development and very much a phenomenon of its century.

The Common Motorist

Social changes, themselves hailed for many years as desirable goals for a community to attain, often come in like the tide—slowly, silently, unannounced and difficult to control. Such a one is motoring for the masses. The provision of a cheap car for everyman is virtually here, as this year's Motor Show emphasises, and has been brought about partly by the miracles of mass production, today taken so much for granted, and partly by the rise in incomes.

But what to do with it now that everyman has got his wish? He has rubbed the lamp and the genie of modern technology has produced the car. Was this the third and last wish or can the genie produce one more wonder. May we now have the roads? These are coming too—though the genie has fumbled this one a bit. And after the roads? Freedom from congestion and parking places. After that he presumably takes to the air. The Motor Show has been warned. It must begin to prepare models for the common spaceman. Perhaps the car, like the radio set, has reached nearly the end of the road.

Union Shops Pay Best

A study recently completed in the United States of wages in comparable jobs in union and non-union shops has provided the trade unions with valuable ammunition for their recruiting campaigns. The survey, conducted by the AFL-CIO research department, was based on industry wage surveys made in the past few years by the US Department of Labour. The results were included in the AFL-CIO Collective Bargaining Report, published last July, and are summarised in the special article in *Labour News from the US* of 11 September, 1959.

The study demonstrates beyond any argument that, to quote *Labour News*, "the wage advantage on union jobs against non-union jobs is so widespread, persistent, and sizeable that there can be no doubt that the fact of unionisation in itself results in higher wages." It was established that wages in union plants were consistently higher than in non-union plants in the same industry. In over 1,000 individual comparisons where the occupation, the industry and the geographic region were the same, the average on the union job was higher in almost 80 per cent of the comparisons. This position held true in every industry studied and in every region of the United States. On the average the worker in the union job received about 8 per cent more than the corresponding worker in the non-union job.

Thrifty Idea Rewarded

For suggesting the use of smaller paper towels for wiping oil and refuse from newly machined parts an employee of Pratt and Whitney Aircraft, Connecticut, USA, won the highest award for the month, $2,500 in the company's ideas competition. The prize is big by comparison with similar awards in this country, but the saving in paper purchasing for Pratt and Whitney will be considerable.

Other ideas submitted in the same month were awarded prizes which, with the paper saving $2,500, reached a total of $5,919. The rest of the prizes are anything from the second, $623 for the recommendation of an economical-to-use carbide reamer, right down to a couple of $3·75 awards.

Hinton on Standards

Sir Christopher Hinton, chairman of the Central Electricity Generating Board, called attention to the need to keep engineering standards under review and up to date when he spoke at the Engineering Equipment Users' Association annual lunch.

Sir Christopher recalled incidents in his earlier career with Brunner Mond and ICI, and war time connections with the Ministry of Supply. These and later experiences had convinced him that standards should not remain static or unaltered for long periods, and that to be really effective, they should not be too wide in range or scope. He appreciated the work and difficulties of the British Standards Institution, who often had to prepare British Standards to satisfy many user and manufacturing requirements. Attempts to satisfy all these demands can, however, reduce the value of standards in important applications.

He said that EEUA, apart from its other activities, was successfully carrying out the type of standardisation work he had originally contemplated when with ICI. A suggestion he had made at that time that ICI might approach a few other organisations with the aim of promoting or adopting joint standards had proved unacceptable on the ground that such action might be regarded by some as forming a "buyers' cartel" which would lead to the setting up of an opposing "sellers' cartel" to the detriment of both sides. The growth and success of the EEUA had shown, however, that such fears were unjustified. Nevertheless, he felt that the possibility of them arising again should be kept in mind by the Association when considering extension of its membership and the scope of its future work.

Electricals' Benevolent Fund

The Incorporated Benevolent Fund of the Institution of Electrical Engineers has been able to report an increase in subscription income in the year ended 1 July, 1959, according to the annual report of the Court of Governors. This follows on appeals by the President at the end of 1957 and also the 1958 appeal. The response on deeds of covenant has been particularly good but the Council point out that only 30 per cent of members subscribe to the Fund.

During the year grants were made in 23 new cases compared with 29 in the previous year. Total number of grants made to beneficiaries was 142 compared with 132 in 1958 and to 122 dependents compared with 112. The average amount per beneficiary was £73. Total income of the Fund for the year was £19,680 compared with £18,875 in 1958 while expenditure was £15,662 against £15,256.

Farewell to Croydon

Technical change has no respect for feelings. Yet, at times these changes have their controversial aspects and moments for sentiment. Such an occasion is the passing of Croydon Airport where 43 years ago civil aviation was born. From 1921 until the outbreak of the Second World War, it was London's main air terminal.

The closing of Croydon is not, however, a straightforward matter of the small and outmoded being replaced by the big and the modern. With Croydon goes readily available customs facilities for small commercial and private planes. The change from Croydon to London Airport or Gatwick is thus not just the arrival of the jet age and a valediction to the small piston engine but the sacrifice of service and convenience for the individual to the claims of mass administrative efficiency. The little man has lost out again.

XUM

Let the Information Officer Inform

The information officer is not there only to keep the library and answer questions. The right man, given the proper backing, is a third eye in the company, seeing and reporting all the news and developments that affect its interests, now and in the future.

By Miss I. M. Slade, Information Officer

British Iron and Steel Research Association

In an age which spends more and more on intelligence, communications and information, it is an unwise firm that neglects its information officer. He has two main functions. He knows where to go to obtain the best answer or advice on a query or problem, and he watches and sifts the stream of incoming information and brings out for closer examination items of likely interest to people in his organisation.

A specialist in finding information as other people are experts in their fields, his essential quality is to have a broad grasp of essentials and an extensive knowledge of where and whom to ask for details.

In order to carry out his functions he must keep in touch with relevant sources of information, especially those nearest at hand and those most nearly related to his firm's interests, and he must have the support of senior management in keeping him closely in touch with those interests. This means he must not only be encouraged to go about the works and talk to people on the job, see the processes operated and their products, but that means must be found for keeping him informed about company policy, and especially with its current problems and plans for new development.

The first requirement—to know relevant sources of information—depends on the information officer's own initiative and ability, the second does not. It depends on senior management and unless some arrangements are made to keep him regularly in touch, the information officer is working in the dark.

IS HE "IN THE KNOW"

This problem of keeping the information officer fully "in the know" must be solved if the company is to have the full advantage of an information department. When it is solved senior managers do not need large numbers of journals marked to them, they can rely on having papers relevant to their current interests sent to them or abstracted for them. It is obvious that they cannot receive this service unless they arrange for their information officer to know what plans and main problems they are considering; it is extremely rare, however, to find that any thought has been given to making such arrangements. When this problem has been considered it has usually been solved satisfactorily. More often, it has not been solved and one not only finds a manager's desk piled with unread journals, but hears complaints from him about the impossibility of reading all that he feels he should. Alternatively he gives up the struggle and says he is too busy to read the journals or even, in the proverbial style of crying "sour grapes," denies that anything of interest to his company is being published.

Company organisation varies so much that the best placing of an information department must depend on the particular circumstances. It is far more important that the information officer should be responsible to someone in a position of influence who is interested in the information service than that he should be in any particular department. In general it is best that he should be directly responsible to a director closely associated with the company's policy, whether it be the director of research, or technical director, or the managing director. When a company has a research department, information departments and libraries are most frequently found under the control of the director of research. This is probably because research workers use the services of an information officer more than production staff who, until they have had this service, seldom realise that solutions to their problems may be readily obtainable by him. To associate information with research is a good arrangement if the research department works closely with the production and administrative departments. It may not be a good arrangement if there is too much division between research and the rest of the company. If the information officer combines his normal responsibility with that for supervising the company's filing, this may require him to be in the company secretary's organisation. Any of these arrangements may work well provided that the information officer has the essential support from top management. It is also important, especially when an information department is newly formed, that he should be easily accessible and not hidden away in a remote corner of the works.

DON'T LET THE CHIEF DO IT

It is entirely wrong that the task of sifting incoming information and directing it to others should be done by the managing director or other senior manager. If he does it properly it takes far too much of his time from other matters that can less easily be delegated. In fact, when he keeps this responsibility, he usually has a clear idea of relative priorities and does it very badly or not at all. It is however equally ineffective to delegate the task to a junior clerk who lacks the necessary knowledge to do it intelligently, even if he (or more usually she) has the ability necessary for grasping the relevance of one to the other. Another wrong choice for information officer is a semi-retired elderly "junior" manager or senior clerk for whom the company wants to find a "soft job." Information work is not a soft job—it requires an insatiable curiosity, persistence, an alert mind, and the ability to see relations between apparently unrelated facts. Hence someone of ability, discretion, and drive should be chosen. He must make many personal contacts and be a good listener. His personality is of the greatest importance. He must have a genuine desire to be helpful, and must have sufficient tact to offer his help without being officious and interfering, and to satisfy his curiosity without being an intrusive nuisance. Specific qualifications must depend on what sort of information is wanted: if the information is mainly technical, then some technical qualification should be looked for. If he is mainly required to provide economic and commercial information, then someone with the appropriate background should be appointed. The chief requirement is a wide general knowledge.

The status of information officer should be between the two extremes mentioned earlier. He must be sufficiently "senior" to be a person of discretion who can be safely trusted with confidential matters concerning his company but, as his function is purely advisory, it is seldom suitable to combine information work with a position in "line" management. The information officer must, however, be able to discuss the matters on which he is required to obtain information on equal terms with the users of his service. Such discussion is most important, as few people ask the questions they think they are asking, and it is nearly always necessary to discuss a problem with an inquirer in order to find out what he really wants to know.

Training in the techniques of information finding and dissemination is needed, as skill may be gained very slowly if it has to be acquired by trial and error. Provided the interest and will are there it is easier to learn these techniques than to acquire technical or academic qualifications.

At present there are no recognised training courses in information work (the Library Association examinations are heavily biassed towards public library work and are largely irrelevant to the sort of information department described here.) The recently formed Institute of Information Scientists is discussing a suitable course of study with ASLIB but it is likely to be a few years before a recognised course is available.

Hence, if the person selected has had no previous experience of information work, the best method of training him quickly is to arrange for him to work in a well established information department for some time. Visits to the main sources of information for the industry should be included.

More should perhaps be said to amplify the statement that library qualifications are usually irrelevant to information work in industry. The number of books required by all but the largest companies is seldom large enough to need the special techniques for classification and indexing that have been developed primarily for large collections such as public libraries. Any company that needs a library of this size will need a librarian in addition to an information officer. An information officer needs a collection of books and journals and other literature because much of the information from which he must sift out what is of interest to his company comes in the written form. Hence it is convenient and usually desirable that his collection of literature and indexes should form part of the company library. His exact relationship to it can vary a good deal according to the kind of collection, its size, etc.; but he will certainly use it more than anyone else and it is usually better that he should control it.

What has been said so far applies whether the information department consists of one part-time information officer or of several or many people. The size that is suitable and economic depends on the scope of the information it is designed to provide as well as on the size and organisation of the company and the variety of its interests. In setting up a new information department, however, it is advisable to go slowly and, unless the needs are clearly known, not to try to set up an ambitious department all at once. There are two reasons for this.

GETTING THE SERVICE USED

In the first place, however able the information officer may be, he has to feel his way, learn what problems are currently concerning his colleagues and learn to know the specific sources and particular people who have the information needed to help them, before he can give a full service.

Secondly, most of the people he is there to help will, if they have not had such a service before, have no idea of how to use it. The information officer's first and often his most difficult task is to persuade people to refer queries to him. As he shows how he can help, how much time he can save senior managers, and that he can produce all sorts of miscellaneous facts promptly, his services will be sought more and more frequently, and the information department will grow in response to needs and not to preconceived ideas of what its size should be.

The information officer must, however, be given enough assistance from the beginning to ensure that he is not entirely tied down by routine work. He must, especially in the early stages of organising his department, have time to go about and get to know both the people who will use it and those who will supply him with answers. The future efficiency of his service depends very much on the efficiency with

which this preliminary work is done. It can of course never be done once and for all. The information officer has to keep his contacts in repair and constantly to make new ones, and for this reason must go about a good deal at all times. The need for immediate answers has to be balanced against allowing him the opportunity of being sufficiently well informed to give intelligent answers.

Keeping information officers tied to their desks is, after isolating them from company policy, one of the main reasons why information departments are unable to give as good service as is attainable.

SCOPE OF THE JOB

It has already been stated that librarians do much that is not necessary for most information work. It is equally true that information officers do a great deal that is not librarianship.

The Institute of Information Scientists defines scientific information work as including.—

(1) Abstracting, reviewing progress and other similar technical writing
(2) translating scientific and technical writing
(3) editing such writings as emerge from (1) and (2)
(4) indexing and subject classification of scientific and technical information
(5) searching scientific and technical literature, preparing bibliographies, reports, etc.
(6) providing scientific and technical information and tendering advice thereon
(7) dissemination of information and liaison and field work for that purpose
(8) research on problems in information work.

Information work in industry covers a wider field and includes commercial, economic, and sometimes legal subjects as well as a great deal of general knowledge.

It may also include many other things which may be described as on the fringe of information work, although less usually included in it, e.g.:

(9) publication of technical books, brochures, house journals, etc.
(10) preparation of material for publication including layout, typography, proof correction, etc.
(11) preparation of material for publicity including exhibition displays, film scripts, etc.
(12) directing films
(13) training
(14) lecturing and arranging for lectures
(15) entertaining visitors and general public relations
(16) organising meetings and conferences
(17) drafting reports, speeches and papers for others.
(18) providing photographs, diagrams and demonstrations.

On the other hand, technical journalists, publicity men, exhibition managers, training officers, conference organisers, librarians, translators, abstractors, technical editors, etc., are not usually information officers. As soon as any of the activities 9 to 17 becomes the man's main activity, or becomes the job for which he is appointed, then he usually ceases to be an information officer and becomes a technical journalist, translator, etc.

It appears, therefore, that an information officer is a jack of all trades though he is not necessarily a master of none. It is good for his organisation and for his position *vis-à-vis* other qualified people if he has some specialisation in a job which requires so much versatility.

SOURCES OF INFORMATION

The nearer at hand any information can be found, the more quickly and easily it can be used. Some of the important internal sources of information which should be made much more use of are.—

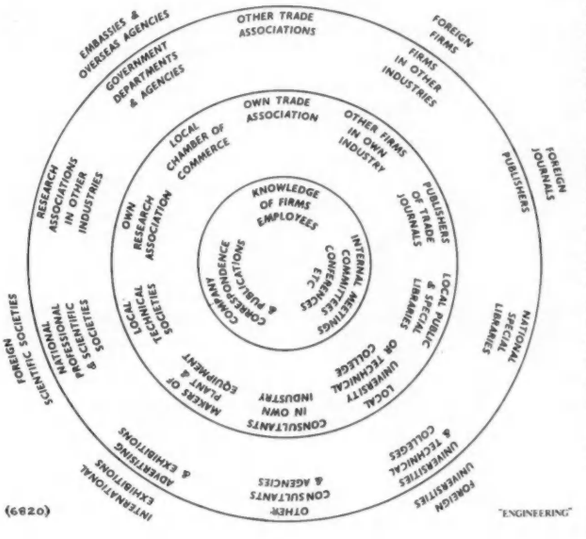
The accumulated knowledge of the company's employees

Company records—files, library, indexes, reports minutes of meeting, correspondence, etc.

Company publications—catalogues, advertisements and other material used for publicity, maintenance and erection instructions.

The means by which the information officer is enabled to use these sources have already been described in general terms. Some more detailed comments attached may indicate how they can be, and sometimes are not, more fully used.

The accumulated knowledge of the firms employees is the source most frequently appealed to by managers when a problem arises. It is a most valuable one but inevitably it fails when a situation arises that is new. It has served extremely well in the past and will always remain important but, with the rapid increase of knowledge, it is likely to become less adequate in future. It is important that the information officer should be given every encouragement to make extensive use of it. He should, whenever possible, be expected to " sit in " at conferences, meetings, and committees, within the firm, as these are usually concerned with matters and problems currently of importance to the company. In many cases he could easily attend but no one has thought of inviting him, and he can seldom take the initiative himself because there is no arrangement by which he can know that the meeting is to take place. If he cannot, or if for some reason it is not considered suitable that he should be present at a meeting, he should at least see any minutes, notes, or memoranda, that are prepared in connection with it.



It should be self evident that information already recorded in the company should be available to the information officer.

A surprising fact shown by the recent survey in the steel industry, was that, in many companies, the reports issued by the research department were not seen by the information officer. This is an absurd situation. He should not only receive the reports but should know what the research and development staff are working on from the beginning, and why, and how successful they have been, and what their recommendations are. He could often save them much time by finding papers on earlier work relevant to their problems.

There is an unfortunate absence of contact between most company's information and publicity departments. Many publications are issued for publicity, including advertisements and catalogues. Information and publicity departments can profit a great deal from each other. Many publicity departments go to great pains to brief their salesmen with the technical details of the company's products. They employ technical writers to describe these products and to produce instructions for erection and maintenance. The information officer can make good use of much of this material, but it is often found that he has not even copies in his library. On the other hand, publicity departments could obtain many of the details they require most easily from the information department.

TWO-WAY CHANNEL

The information officer's second function is to be a channel between his own and other organisations through which information flows in both directions. It cannot be emphasised too strongly that this two-way flow of information is essential to the efficiency of any information department. If any information officer is to continue to receive quick and helpful answers from others, he must be prepared to help them in return. He should not therefore be hampered by unnecessary secrecy. However confidential much of his knowledge of the internal affairs of his own organisation may be, he inevitably knows much that can be divulged without harm. It is too often found that everyone in an organisation has been so impressed by the need to avoid betraying confidence, that much is suppressed unnecessarily. This instruction to treat harmless information as confidential is usually due to lack of confidence in the information officer's judgment and it can only be repeated that someone whose judgment can be trusted should be appointed, and that, where he cannot be expected to decide for himself, clear indications as to what is really confidential should be given. Putting everything into this category, eventually prevents the information officer from keeping the confidence of the people who can best help him.

External sources are so varied that it is impossible to give an exhaustive list. Some of the important sources are given in the diagram. The circle in the centre represents the company itself, the next ring represents near sources, e.g. within reach of a local telephone call. Then come national sources and round the edge a few outside one's own country. All these organisations will provide information and between them can provide it on almost any topic.

An efficient information officer will know the sort of information he can expect from each and will select from the large number of individual organisations included under each heading, the one that has the particular information he is seeking. In order to do this quickly, he needs to know a great many people so that he can select not only the right organisations but the right person in it. The links between the sources mentioned and a great many others not listed are many and no attempt has been made to indicate them.

USE OF SOURCES

Not all of the sources listed are useful to all companies all the time but most are relevant at some time and could be used much more than they are.

Most companies belong to a trade association, and most such associations provide their members with information. Local trade associations and chambers of commerce have differing degrees of information at hand. While many public libraries have little in the way of technical books, all have facilities for borrowing throughout the country and, in addition to this, frequent demands upon a library may result in suitable works being added.

The information officer should visit other companies in his own and related industries and it is important that when other members of the firm make visits he should see a copy of their report. This applies equally to visits abroad and reports should not be withheld as " too confidential." If the information officer cannot be trusted with confidential information, he should not be appointed.

Encased Steel Stanchions and BS 449

BS 449 : 1959 permits the concrete casing of encased steel stanchions to be assumed to contribute to the load carrying capacity of the stanchion. Tests at the Building Research Station justify the design rules of the new Standard.

By R. F. Stevens, M.Eng.
Building Research Station, DSIR

Steel stanchions forming part of a multi-storey building are usually encased in concrete for protection against fire. An investigation of the stiffening and strengthening effects of this concrete encasement is being made at the Building Research Station.

The tests on full-size encased stanchions described here were made to determine the effect of concrete encasement on stanchions subjected to axial or eccentric compression. The investigation is a continuation of previous tests on small-size encased stanchions, made at the Building Research Station,[1] and on full-size encased stanchions, made by the late Dr. Oscar Faber for the British Constructional Steelwork Association.[2]

It is of interest to note the changes that have been made in BS 449, *The Use of Structural Steel in Building*, with respect to the permitted load-carrying capacity of concrete-encased steel stanchions. Prior to 1948, the provision of concrete encasement to a steel stanchion was not accompanied by any increase in the permissible load on the stanchion. Some allowance was made for the stiffening effect of the concrete encasement in the 1948 edition of the standard by assuming that the least radius of gyration was effectively increased beyond that of the bare steel stanchion. In the 1959 edition just issued,[3] recognition of the strengthening effect of the concrete encasement has been taken a stage further, by permitting the concrete to carry load over its cross-sectional area, assuming (for mild-steel stanchions) that the concrete stress is one-thirtieth of that permitted in the steel.

EXPERIMENTAL DETAILS

Two series of tests were made: Series A, in which encased stanchions of varying slenderness ratios were loaded to failure in axial compression; and Series E, in which encased stanchions of a constant slenderness ratio were loaded to failure under various eccentricities of load to cause bending about the minor axis. Five encased stanchions (A1-A5) of Series A were tested, and twelve (E1-E12) of Series E. In addition, one uncased steel stanchion was tested in axial compression (E13), and one uncased stanchion in eccentric compression (E14).

The stanchions comprised 12 in by 8 in rolled steel I-sections with a minimum concrete cover to the steel of 2 in, the overall cross-sections being rectangular and measuring 16 in by 12 in. The heights of the axially loaded stanchions ranged from 3 ft to 15 ft; the height of all eccentrically loaded stanchions was 15 ft. All the steel stanchions were provided by the British Constructional Steelwork Association, to the specification of the Building Research Station, accurately cut to length and with the ends machined square.

The yield stress of the steel was found to be 14·7 tons per sq. in, and the modulus of elasticity was $29{\cdot}5 \times 10^6$ lb per sq. in. The concrete for the encasements was designed to attain a strength of 3,500 lb per sq. in at 28 days. In fact, control cubes cast with the stanchions ranged in strength from 3,350 lb per sq. in to 4,150 lb per sq. in.

The encasements of the stanchions of Series A were reinforced with a 6 in square mesh of 10 s.w.g. hard-drawn steel wire. The encasements of the stanchions of Series E were reinforced with $\frac{1}{4}$ in diameter binders at 6 in centres wired to four longitudinal $\frac{1}{2}$ in bars, the binders being positioned so as to pass through the centre of the covering of the edges and outer faces of the flanges; this reinforcement complies with the requirements of BS 449 for cased stanchions. The difference of encasement reinforcement between the two series is known to be of no consequence.

Stanchion E12 (15 ft long) was tested to failure as a beam in bending about the minor axis; it was simply supported over a span of 10 ft and was subjected to third-point loading.

AXIALLY LOADED STANCHIONS

The principal results of the tests on axially-loaded stanchions are set out in Table I.

The working loads were determined according to the provisions of clause 30b of BS 449 : 1959. The allowable stress in the steel was obtained from Table 17 of the Standard on the basis of a slenderness ratio corresponding to a radius gyration of $0{\cdot}2\,(b + 4)$ in, where b is the overall width (8 in) of the flange in inches. The allowable stress for the concrete was one-thirtieth of that for the steel. Although the wording of the Standard might be interpreted as permitting the *gross* section of the concrete to be used in the calculations, it is more rational to use the *net* area (i.e. the overall area less the area of the steel section) and this has been done for the purposes of this article; the difference in allowable stanchion load deduced on the two bases is, however, only 1 to 3 per cent.

All the encased stanchions failed by crushing of the concrete and yielding of the steel in compression on one face a little above the mid-height. This crushing was followed by tensile cracking of the opposite concrete face. This failure, a little above the mid-height, indicated that the concrete of the upper half of the stanchion was weaker than that at the bottom.

In the tests made to provide a direct comparison of the strengthening effect of concrete encasement, the ultimate load of encased stanchion A5 was a little more than twice that of a similar bare stanchion, E13.

The load factors for the encased stanchions (i.e. the ratio of the ultimate strength to the working load) ranged from 2·20 for the shortest stanchion, A1, to 3·07 for the longest, A5. In comparison, the load factor for a very short bare stanchion would be about 1·7; that for the 15 ft bare stanchion was 2·44. The load factors for the encased stanchions increased as their slenderness increased, showing that the reduction in load-carrying capacity of encased stanchions with increasing slenderness was not as great as the reduction given in the Standard.

ECCENTRICALLY LOADED STANCHIONS

The principal results of the tests on eccentrically loaded stanchions are set out in Table II.

The working loads were calculated according to the rules in clause 14a of the Standard, which states that the quantity

$$\frac{\text{calculated axial load}}{\text{allowable axial load}} + \frac{\text{calculated compressive stress in bending}}{\text{allowable compressive stress in bending}}$$

must not exceed unity. In this expression, the allowable axial load is that of the cased strut. The actual bending stress, however, must be calculated for the uncased section without allowance for any strengthening by the concrete. The allowable compressive stress in bending can presumably take into account the effect of encasement, in accordance with the rules for cased beams (in clause 21 of the Standard), which would be appropriate for a stanchion bent about its major axis. For a stanchion bent about the minor axis, as in the present tests, the allowable compressive stress in bending would usually be 10·5 tons per sq. in, without reduction even for an uncased member, so that this stress can safely be adopted for the cased stanchions.

Since a load P applied with an eccentricity e is equivalent to an axial load P and a bending moment of Pe, the allowable eccentric load for the 15 ft stanchions is given, in tons, by

$$\frac{P}{138} + \frac{Pe/z}{10{\cdot}5} = 1$$

where

e is the eccentricity in inches
138 tons is the allowable axial load
10·5 tons per sq. in is the allowable compressive stress in bending and
z is the section modulus for bending about the minor axis (16·3 in³ for a 12 in × 8 in section).

Hence $$P = \frac{138}{1 + 0{\cdot}81e}$$

The allowable loads so calculated are given in Table II.

The encased stanchions failed either by (*a*) crushing of concrete and yield of the steel in compression over part of one face of the stanchion a little above the mid-height, accompanied by tensile cracking of the concrete on the opposite face, or (*b*) tensile cracking of the concrete and yield of the steel in tension on one face of the stanchion, accompanied by crushing of the opposite concrete face.

An attempt was made to determine whether compressive or tensile yield of the steel governed failure for each of the stanchions, by the measurement of steel strains. These indicated that compressive yield of the steel governed the failure of the encased stanchions for eccentricities of load up to 6 in, and tensile yield for 7 in and 8 in eccentricities of load.

A direct comparison of the strengthening effect of concrete encasement on eccentrically loaded stanchions was provided by stanchions E4, E5 and E14. The ultimate loads of both the encased stanchions were more than twice that of the similar bare stanchion.

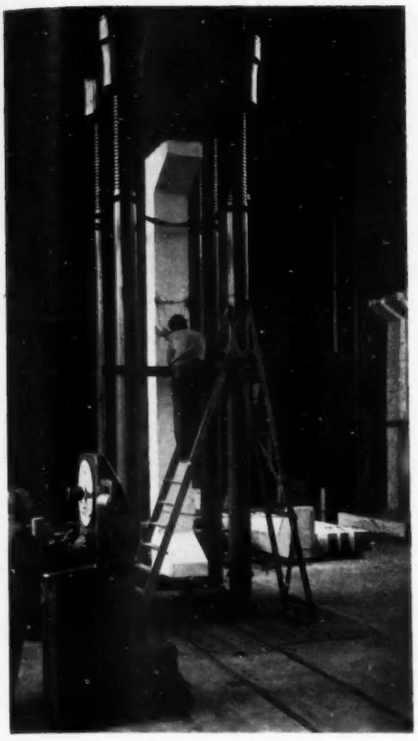
The load at which tensile cracking of the concrete commenced was reduced as the eccentricity of load was increased, ranging from about

TABLE I.—*Results of Tests on Axially Loaded Stanchions*

Encased Stanchion No.	Height, ft	Slenderness ratio	Ultimate load, tons	Working load (BS 449 : 1959) tons	Load factor
A1	3	15	478	217	2·20
A2	6	30	450	197	2·28
A3	9	45	421	178	2·37
A4	12	60	426	158	2·70
A5	15	75	424	138	3·07
E13 (uncased)	15	98	205	83·8	2·44

TABLE II.—*Results of Tests on Eccentrically Loaded Stanchions*

Encased Stanchion No.	Eccentricity of load, in	Load at commencement of tensile cracking of concrete, tons	Ultimate load, tons	Working load (BS 449 : 1959), tons	Load factor
E1	0	440	440	138	3·19
E2	0	471	471	138	3·42
E3	1	300	300	76·3	3·93
E4	2	140	217	52·8	4·11
E5	2	114	230	52·8	4·35
E6	3	90	161	40·3	4·00
E7	4	55	132	32·6	4·05
E8	5	20	117	27·4	4·27
E9	6	20	103	23·6	4·37
E10	7	10	89	20·7	4·30
E11	8	10	75	18·5	4·05
E12	Failed under a bending moment of 704 ton-in Allowable moment (BS 449 : 1959), 171 ton-in				4·11
E13 (uncased)	0	—	205	83·8	2·44
E14 (uncased)	2	—	97	42·4	2·29



Tests on eccentrically loaded encased steel stanchions in the 1,000 ton hydraulic press at the Building Research Station.

50 to 65 per cent of the ultimate load with a 2 in eccentricity to about 15 per cent of the ultimate load with an 8 in eccentricity of load.

The load factors for the encased stanchions were greater for eccentric than for axial loadings. The increase in load factor occurred for small eccentricities of 1 and 2 in; for larger eccentricities (including the limiting case of pure bending), the load factor remained nearly constant, at about 25 to 30 per cent greater than that for an axially loaded encased stanchion.

DISCUSSION OF RESULTS

The encasement of steel stanchions in concrete resulted in important increases in strength for both axial and eccentric loading, fully justifying the allowances in the new version of BS 449, which can lead to savings of about 30 per cent in the amount of steel in stanchions.

The load factors for the encased stanchions subjected to eccentric loading (3·9 to 4·4) are somewhat greater than is usual for steel-concrete members, indicating that still greater allowance may be possible, when further data are available, for the strengthening effect of encasement on eccentrically loaded stanchions. The present interaction formula used in BS 449 for estimating the effects of eccentric loading is clearly conservative, at any rate for bending about the minor axis.

Acknowledgments.—The work described in this article forms part of the programme of research of the Building Research Board, and is published by permission of the Director of Building Research. Thanks are due to the British Constructional Steelwork Association for providing the steel stanchions used in the tests.

REFERENCES

[1] F. G. Thomas, "The Strength of Encased Steel Stanchions," ENGINEERING, vol. 180, page 759 (1955).

[2] O. Faber, "Savings to be Effected by the More Rational Design of Cased Stanchions as a Result of Recent Full-Size Tests," *The Structural Engineer*, vol. 34, No. 3 (1956). See also ENGINEERING, vol. 180, page 855 (1955).

[3] BS 449 : 1959, *The Use of Structural Steel in Building*, British Standards Institution, London (price 15*s*, postage extra).

Pneumatic-Tyred Rollers and Soil Compaction

Road Research technical paper No. 45, *Investigation of the Performance of Pneumatic-Tyred Rollers in the Compaction of Soil*, discusses the use of plant weighing up to 45 tons for the construction for large embankments. It is the third in the series describing investigations of the performance of plant used for compacting soils. The author is Mr. W. A. Lewis, of the Road Research Laboratory, and the paper has been published for DSIR by HM Stationery Office, price 3*s* 6*d*.

The investigation showed that increases in wheel load or tyre pressures produce an increase in the maximum dry density of the soil with a corresponding lower optimum moisture content. For clays, no advantage was gained by employing tyre pressures above 40 to 50 lb per sq. in or wheel loads above 5 tons; granular soils, however, were better compacted by using the highest pressures and wheel loads practicable.

In general, four passes of the rollers gave compactions equivalent to an air-void content of 10 per cent. To obtain such an air-void content of 10 per cent, the maximum loose layer that could be placed was between 6 in and 9 in for light wheel loads, but up to 18 in if the heaviest were employed. The paper shows how roller performance can be estimated given the contact areas and tyre pressures of the roller, and shear strength, dry density and moisture content of the soil. Since both the output of rollers and the cost of operation increase at about the same rate, the resulting cost per unit volume of compacted soil was not found to be very different for various sizes of roller.

Design and Construction in Aluminium : Course

The Institute of Welding, in conjunction with the Aluminium Development Association, have arranged a course of instruction on welding design and construction in aluminium and its alloys. The course will include welding methods, material selection, metallurgy, design, inspection and testing, applications, and recent developments. Lectures will be combined with discussions, film shows and visits to works and laboratories.

The course will be held at the Institute's headquarters from 9 to 13 November, 1959, inclusive; the fee, which includes transport to works visits, is £18 18*s* for non-members and £14 3*s* 6*d* for individual members and staffs of industrial corporate members. Applicants are expected to have received full engineering or metallurgical training. The number that can be accepted is limited and application should be made to the Institute of Welding, School of Welding Technology, 54 Princes Gate, London, SW7.

Laminated Timber Manufacture in North America

The manufacture of glued laminated timbers in North America is reviewed in a new publication issued by the Timber Development Association. The report has been written by Mr. W. Chugg, who is in charge of the association's "glulam" research, following an extensive fact finding tour of Canada and the United States. Copies can be bought from the TDA, 21 College Hill, London, EC4, price 10*s*. (It follows an earlier companion report by the association's architect, Mr. E. Levin, on the practices adopted in Western Europe; copies of this report, first published in 1956, cost 3*s* 6*d*.)

In North America it was found that casein of a water and mould-resistant type was in general use for interior work and phenol resorcinol formaldehyde for outdoor structures; no evidence was seen of the use of urea formaldehyde. Both in the text and in the illustrations the reporter emphasises the use there of large sized jigs that can accommodate a number of beams simultaneously; often 10 or even 20 members are cramped in a jig at the same time. Apart from red and white oak for marine use, Douglas fir is the timber most employed for structural work.

One chapter of Mr. Chugg's report is devoted to factory administration, showing how adequate supervision is maintained throughout the production sequence.

Manchester to have High-level Motorway

Manchester plans to build a high-level road 1,200 yd long to relieve traffic congestion in the city centre. The road will be 22 ft above ground and there will be two intermediate access points along its length, one from a clover-leaf, the other by way of straight ramps. Including the cost of acquiring land and demolishing certain buildings, the project is expected to cost £6 million. Construction work will begin in September, 1961, and it is aimed to open the road by the end of 1963.

It will be the largest overhead urban road designed in this country. There will be no pavement and it is expected that a large proportion of the traffic using it will be heavy goods vehicles.

Locked Coil Ropes for Tamar Bridge

Nearly 4,500 miles of wire weighing 850 tons will go to the making of the main cables of the river Tamar suspension bridge. This £200,000 order placed with British Ropes Limited calls for 62 separate ropes each about 2,200 ft in length and 2·37 in in diameter.

The Tamar bridge will use locked coil ropes for the suspension cables and it is probably the first time such ropes have been used in England. Manufacture is due to commence at the company's Doncaster plant during October of this year. It is hoped to have the bridge open to toll traffic in 1961.

The bridge, for which the Cleveland Bridge Engineering Company Limited are the main contractors, will relieve traffic congestion on the Devon-Cornwall border. It will stand 134 ft above high water, have a main span of 1,100 ft, and run parallel to Brunel's 100 year old Royal Albert Bridge on the Western Region main line.

Concrete Developments in Ontario

In 1958 the Hydroelectric Power Commission of Ontario brought into commission 800 MW of new or extended generating capacity. By the end of the year work was in progress at five hydraulic and three conventional thermal stations; an extra-high-voltage (600 kV) transmission grid is planned for the region. These facts are given in the 51*st Annual Report* of the Commission, just published, which also gives full descriptions of the completed and planned stations, including the St. Lawrence power project. Breakdown figures for current supplied to different areas in the region are also given.

In the section on research and testing it is noted that the use of fly-ash is being extended; 1,200 tons are to be used in the concrete for the Otter Rapids generating station. Work has also been done on lightweight fly-ash aggregates and on the stabilisation of in-place materials for road base-course construction. It has also been found that concrete can be placed satisfactorily if a limit is put, not on the minimum period between lifts, but on the maximum period. In this way the tendency for low-lift concrete to crack vertically is eliminated and the principal advantages of both low and high-lift placing are realised. Hitherto the Commission has always used high-lift placing ; but in future the modified low-lift procedure is to be adopted.

XUM

Canadian Reactions

WITH the signing of the Canada-Euratom agreement, the European Atomic Community has made alliance with all three war-time partners in nuclear research; with the United States on 8 November, 1958, with the United Kingdom on 4 February, 1959, and with Canada on the sixth of this month. Any advantage these three countries may still have over Europe's industrial powers in the development of atomic energy has been relinquished under the agreement; and experience in reactor physics and engineering, material testing and manufacture becomes available to all. Europe is the ultimate beneficiary of these countries' single-minded efforts in developing respectively the pressurised water, the gas-cooled and the heavy-water reactors. Canada has had some setbacks in her development programme which has also been subjected to considerable criticism, but her determination to press ahead is undiminished.

Terms of Agreement

A $10 million budget, contributed half-and-half by Atomic Energy of Canada Limited (AECL) and Euratom, will form the financial basis of cooperation for the first five-year period. The agreement provides for the exchange of information on research, development, equipment design and its use, health and safety. The two partners will facilitate the granting of patents, and will mutually provide technical advice and training facilities. Inventions and discoveries will be shared between AECL and Euratom, although each partner will retain patent rights at home.

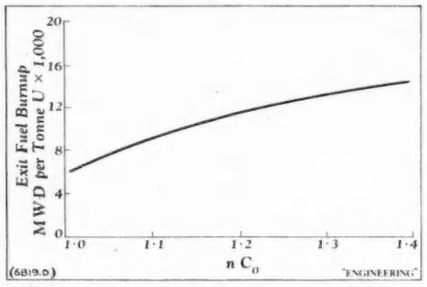


Fig. 1 Variation of burnup with enrichment.

Scope of Collaboration

Exchange of information and research under the agreement will be mainly on aspects of the heavy-water moderated reactors which have been under development in Canada for eighteen years. More recently the heavy-water organic-liquid cooled concept has been studied by Canadian General Electric, and considerable interest has been shown in this reactor by European manufacturers. Although Atomic Energy of Canada has so far not shown much interest in high-temperature gas-cooled reactors, there is the independent venture of Daniels-Boyd, and Brown Boveri—Krupp of Euratom have such a design under study and the possibility of exchange exists (see Atomic Review 11 Sept. '59). A review of the status of atomic energy in Canada appears below. Atomic Review has previously reported on Canadian developments in World Programme on 12 December, 1958.

Fate of the Heavy Water Reactor

Power reactor development in Canada has been characterised by competition with extremely cheap and abundant hydroelectric sources. Dr. W. B. Lewis, vice-president of AECL, has repeatedly expressed the opinion in the face of criticism that only the heavy-water moderated reactor can hope to become competitive under these conditions. His staff have explored the methods of reducing fuel and capital costs, and confidence in their results is reflected in the decision to construct the 200 MW(e) station Candu. His chief critics are Mr. Winnett Boyd, the designer of Chalk River's NRU reactor, and American Standard from south of the border, who have undertaken an independent economic analysis. Power reactor development has reached an interesting stage in Canada: the policy of the monolithic government agency Atomic Energy of Canada is being challenged by individuals and outside bodies.

The Challenge

Of the challengers, Mr. Winnett Boyd, is somewhat of a rebel. Having been intimately connected with the development of the heavy-water reactor, NRU in particular, he came to the conclusion that the economic, thermodynamic and safety limitations of the reactor did not justify Canada's concentrated effort. He ridiculed the idea of "a national reactor type" and embraced the suggestions of Dr. Farrington Daniels for a high-temperature ceramic-fuel active-circuit reactor now known as the Daniels-Boyd Nuclear Steam Generator. Atomic Review reported on engineering features of the proposal on 11 September, 29 May and 3 April of this year. Mr. Winnett Boyd's criticism of the heavy-water reactor may be summarised as follows. Heavy water is expensive ($56,000 per ton) and is not produced domestically. The need for fuel shuffling makes heavy-water losses inevitable when connections are made or broken. The steam cycle suffers from the flat coolant curve characteristic of pressurised-water reactors and from the low maximum cycle temperature imposed by the need for pressure containment. The use of pressure tubes, while overcoming some difficulties, leads to reduced thermal inertia in the core and requires a highly sensitive control system. Finally, the heavy-water reactor promises to be economic only in very large sizes.

Doubts About Cost

American Standard and other American parties interested in heavy-water moderation, do not directly attack Atomic Energy of Canada, but their cost analysis contradicts the figures of Dr. Lewis in more than one way. They advocate the use of slight enrichment and stainless-steel cladding instead of natural uranium and zirconium. More important, American analyses consistently resulted in higher unit costs than those from Chalk River: around 10 mills per kWh against 6·15 mills per kWh quoted by Dr. Lewis at the World Power Conference meeting in 1958. Most embarrassing of all, the Americans do not agree that the heavy-water cooled and moderated reactor is cheaper than other types, and make no further attempt in their vast atomic programme for its study. Of all possible combinations, the heavy-water moderated gas-cooled reactor is alone under development south of the border. Table I shows a comparison of the conflicting estimates of nuclear power costs.

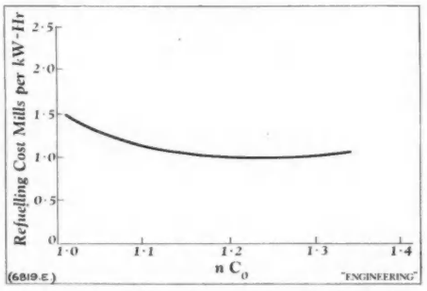


Fig. 2 Effect of enrichment on refuelling cost.

Chalk River's Response

Chalk River was not unaware of the heavy-water reactor's shortcomings even before criticism became vocal, but it is in the nature of dialectics that the response was accelerated by public discussion. The controversy over power costs will not be settled until the auditors have finished adding up the costs of the power reactor Candu. In the meantime Dr. Lewis maintains that pressure tubes (not considered by American Standard), long irradiation times and careful design will make his reactor economical. The excellent neutron economy of the heavy-water and zirconium-can combination permits irradiation without reprocessing of the order of 10,000 MWD per tonne. Pressure tubes reduce capital costs and facilitate two-directional fuelling; and to provide a fast response in the control system, the gas-pressure supported moderator was developed, which permits sudden dumping of the moderator from the reactor core. Finally, to reduce the cost of heavy-water inventory and the danger of pressure-tube burst, Canadian General Electric was commissioned to prepare a design-study of a 250 MW(e) organic-cooled heavy-water reactor.

Organic Cooled Heavy Water Reactor

The contract for the development of the organic-cooled heavy-water reactor (OCDRE), awarded to Canadian General Electric, is valued at $600,000. The reactor will use natural uranium fuel in large and enriched uranium oxide in smaller plants. It is hoped that the reactor will be competitive with light-water moderated plants developed in American even in small sizes. M. J. McNelly of CGE reported on a 150 MW(e) plant at the nuclear engineering and science conference held at Cleveland, Ohio, in April this year. Advantages of the concept are obvious: a combination of the best moderator and a low pressure coolant is attractive provided the mechanical complications—already abundant when handling heavy water alone—do not become excessive. The use of organic coolant reduces the heavy water inventory from $55 per kW for Candu to $35 per kW, and enables the use of a greatly improved steam cycle. The heavy-water inventory of the Vickers Nuclear Engineering steam-cooled reactor appears to be around $32 per kW (see ENGINEERING, page 792, 8 June, and pages 8, 7 August, 1959).

Fuel Costs

CGE have studied the effect of enrichment on fuelling costs in some detail in spite of AECL's preoccupation with natural uranium. Enrichment affects plant economy, through increased burnup and variation in uranium cost. CGE propose to use aluminium-clad sintered uranium-oxide fuel; with this combination, and organic coolant, the maximum expected burnup for natural uranium is below 6,000 MWD per tonne. Fig. 1 shows the variation of attainable burnup with slight enrichment. The cost analysis shown in Fig. 2 shows that the most economical fuel is in fact enriched about 1·2 per cent although the curve is conveniently flat between 1·15 and 1·35 per cent to permit a latitude in choice. Dr. Lewis has stated on several occasions that nuclear fuel-costs must be below 1·3 mills per kWh in order to compete with conventional plants even in high coal-cost areas. The implications of Fig. 2 appear to exclude natural uranium, the mainstay of Canada's programme, from the competitive range.

Reheat Steam Cycle

Costs of conventional plant components are reduced by improvements in the steam cycle, a novel feature of which is the use of reheating. To minimise losses and to reduce the length of high-pressure steam piping, the reheat unit may be located in the turbine-house and a portion of the organic coolant stream diverted to it through low-pressure pipes. Fig. 3 shows a temperature diagram for the steam-raising units and the reheater. It is expected that single-stage reheating will improve the cycle efficiency by about 1 per cent. More significant improvement in turbine performance results from the higher operating temperature possible with organic coolant. The reactor outlet temperature is 800° F (427°), 270° F higher than for NPD-2 and 50° F higher than the gas-cooled reactor for Trawsfynydd, but falling short of the Vickers steam-cooled proposal using 970° F (520° C) outlet temperature. The theoretical cycle efficiency is over 31 per cent, 6 per cent better than the best pressurised heavy-water cooled reactor to date.

Control System

Close cooperation between Chalk River and CGE is shown in the design of the control system which is very similar to that used on the NPD reactors and the redesigned NRX. No absorbing rods are used; instead, reactivity is controlled by the level of the moderator. The "gas-balance" control system was developed after the NRX accident, and uses differential pressure maintained by a gas-blower to support the moderator in the core-tank. Shut-down is automatically initiated by the failure of any component affecting the pressure balance—the blower, the core tank, the pressure tubes, or the gas circuit—and hence results in inherent safety. Deliberate shut-down is effected by tripping the actuator of valves bypassing the blower or stopping

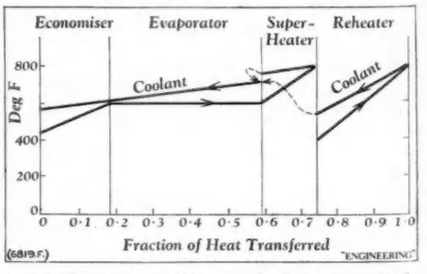


Fig. 3 Temperature diagram of reheat steam cycle.

the blower. Owing to the large rotor inertia of the blower, the latter method is too slow for emergencies.

Fuel Storage Inside Pressure Vessel

The pressure vessel has several unusual features. Owing to the non-corrosive nature of the coolant, mild steel and aluminium components are used extensively. The coolant pressure is only 166 lb per sq. in instead of 1,130 for NPD-2. Referring to Fig. 4, a head tank filled with coolant provides shielding for the top of the reactor and also serves to store fuel elements. The coolant flows upwards through the aluminium reactor tank to insulated fuel channels designed to keep the moderator temperature at 120° F (49° C). Fuel is introduced into the core through a check-valve that prevents circulation of primary coolant in the head tank. The liquid in the head tank is maintained at room temperature by means of a small separate coolant system.

Candu on Again

After many policy changes and schedule revisions, the construction of the 200 MW(e) station Candu was finally given government approval in June. For financing the $60 million station a procedure will be adopted similar to that employed in the American power demonstration projects. The government provides funds through its atomic agency, while a public utility company, Ontario Hydro in this case, provides the site and electrical interconnection and undertakes to operate the station by purchasing the generated electricity until the station's suitability is proved. Candu was first designed in 1957 by the Chalk River staff, but extensive revision is expected before construction begins. The site of the station, although not yet approved, is expected to be near Kincardine, on Lake Huron. Dr. Lewis estimates that the nuclear power programme in Canada will require an inventory of about 4,000 tonnes of heavy-water and 2,500 tonnes of natural uranium by 1980, with an annual uranium make-up of 700 tonnes. All the uranium can be produced at home, but the heavy-water, worth $224 million, would have to be imported unless domestic production facilities are created. The value of all Canadian imports in 1958 was about $5,200 million, while Canadian uranium-oxide production is about 7,000 tons per year.

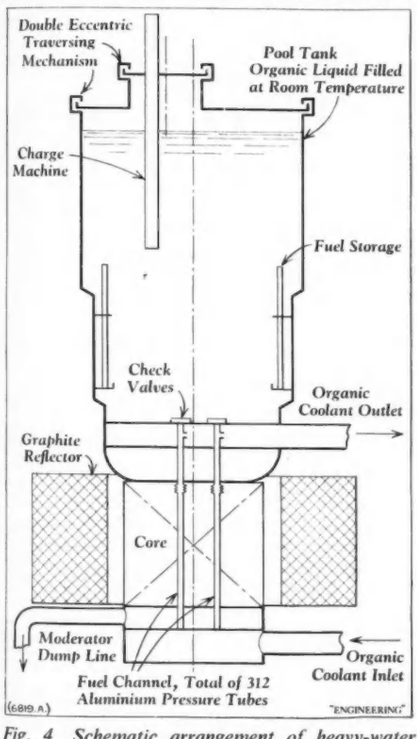


Fig. 4 Schematic arrangement of heavy-water moderated organic-liquid cooled reactor.

Test Facility for Candu Fuel

A new pool-type heavy-water reactor very similar to ZEEP is now under construction at Chalk River. The reactor, known as Zed-2, will be used for irradiation-testing of various fuel-element designs proposed for the power reactor Candu. Detail design and construction of the $3 million reactor was undertaken by Canadian Foster Wheeler of St. Catherines, Ontario, in collaboration with the reactor physicists of Chalk River. Zed-2 will be the fourth reactor at Chalk River, following ZEEP, NRX and NRU.

TABLE I.—*Estimates of nuclear power costs in North America at 80 per cent load facto*

Source and interest charges, per cent	Type	Output, MW(e)	Fuel exposure, MWD/tonne	Enrichment, per cent	Cost per u.s.o., mill per kWh
Winnett Boyd Limited .. .. .. (8·5-capital) (4·0—fuel)	HTGCR	400	9,800	1·0	5·3
American Standard .. .. .. (15—capital) (12—moderator)	Heavy-water, boiling ..	250	8,000	1·4	10·4
	Heavy-water, pressurised	250	8,000	1·4	10·9
Atomic Energy of Canada Limited .. (10—capital) (4—fuel)	Heavy-water, pressure tube	200	8,000	Nil	6·15
	Boiling water, Dresden ..	180	10,000	1·5	8·81
	Pressurised water, Yankee	134	8,000	2·6	8·87
	GCR Hunterston ..	150	3,000	Nil	8·56
Canadian General Electric Company .. (12—capital)	Heavy-water, organic-cooled	250	12,000	1·2	7·8

Construction of NPD-2 in Advanced Stage

Civil engineering work on the construction of the 20 MW(e) plant NPD-2 for the demonstration of the heavy-water power reactor concept is in an advanced stage, and completion of the reactor building is expected before the onset of the cold season. The plant is constructed on a site provided by Ontario Hydro near Rolphton, a few miles from Chalk River and the Des Joachim hydroelectric power station, and will feed the electrical network through the Des-Joachim switchyard. The NPD reactor was originally designed as a prototype for the 200 MW(e) station Candu and was based on the pressure-vessel rather than pressure-tube principle. Simultaneously with the start of construction AECL began the design study of Candu, which showed the practicability of pressure-tubes. Construction was halted at the NPD site and the reactor core redesigned in its present pressure-tube form known as NPD-2. The station is expected to produce power by 1961, giving four years of operating experience before Candu is completed in 1965.

Anglo-Canadian Nuclear Link Urged by Winnett Boyd

In a luncheon address to the Engineering Institute of Canada, delivered on 15 October, 1959, Mr. Winnett Boyd urged close cooperation between Britain and Canada in their nuclear power programme. His suggestion was based on the opinion that high-temperature gas-cooled reactors—needing some enrichment—would replace the natural-uranium reactors now under construction in both countries. (See also " Power Programme Comment " in Atomic Review, 9 October.) He suggested creating a unified enrichment facility using low-cost hydroelectric power available in Canada, and closing the less economical Capenhurst enrichment plant. Canada could also supply all the helium-requirements of the programme from the natural-gas fields of Alberta, which hold the second largest reserve of helium known in the world. Petroleum coke and a well-established graphite industry are also available in Canada. Mr. Boyd urged that some of Canada's engineering resources should be diverted to the development of the HTGCR in cooperation with Britain, and suggested that an impartial committee, possibly from abroad, should be appointed to review the future of the heavy-water programme in Canada.

Experience with Plutonium

Looking beyond the immediate requirements of the Canadian nuclear power programme, considerable experimental work has been performed at Chalk River on plutonium irradiation. Dr. Lewis has stated in the James Clayton lecture that Canada now has " the most extensive known experience on the use of plutonium as a working fuel," amounting to 1,500 MWD irradiation of 5·5 kg plutonium. O. J. C. Runnalls of AECL has reported on experience with plutonium-aluminium alloy fuel elements at the second Geneva conference (Paper P191). Three different designs were irradiated in the NRX reactor, with alloy compositions varying from 0·5 to 20·8 per cent plutonium by weight. Following failure of several elements the canning was redesigned and the new elements are now operating satisfactorily with a maximum heat flux of 190 watts per sq. cm and 3·7 per cent plutonium content by weight. It is expected that 3 kg of fresh plutonium will become available for experiment annually.

Canadian-Pakistan Pact

Canada and Pakistan signed an agreement in Ottawa on 14 May for cooperation in the peaceful uses of Atomic Energy. The agreement also provides for the signing of a contract under which Canada will sell uranium to Pakistan.

Canadian Cancer Treatment Machines to China

Four AECL cancer treatment machines together with their cobalt-60 radiation sources have been shipped to China. The shipment is valued at $180,000. Two cancer treatment machines were purchased from Canada by China last January and the total value of shipments to date is $300,000 AECL has exported 160 cancer therapy machines to 27 countries and the total value of these units and their radiation sources is about seven million dollars. Six different models of the cobalt-60 therapy machines and a caesium-137 therapy machine are now being manufactured.

Western Counterpart to Chalk River

A new nuclear energy research centre will be built by Atomic Energy of Canada Limited in Manitoba. The need for the new establishment arose from large expansion in nuclear research at Chalk River, which now has reached a dangerous size. First steps in decentralisation were the relocation of the nuclear power plant division in Toronto, and the commercial products division in Ottawa. The new centre in Manitoba will be devoted to the development of the heavy-water moderated organic-cooled natural uranium power reactor.

Chalk River Reactor School

A 12 week reactor school open to foreign students will begin at Chalk River, Ontario, on 1 February, 1960. The course, conducted by Atomic Energy of Canada, will be primarily concerned with heavy water-moderated systems, of which both heavy water and organic liquid cooled versions are under study at Chalk River. The students will have access to the research reactors NRX, NRU, and ZEEP. No degrees or certificates will be granted, though examinations may be held to evaluate the students' progress. The fee of $600 includes books and laboratory costs, and it is estimated that an additional $575 will be needed for living expenses.

Organic Growth

Interest in nuclear marine propulsion continues long after the proposals submitted to the Galbraith committee were made public. As a consequence a second generation of marine reactors is being launched which incorporate the results of continued development work. A paper by E. C. B. Corlett, director of Burness, Corlett and Partners, naval architects, and E. P. Hawthorn, chief executive of Hawker Siddeley Nuclear Power Company, which was read to the joint panel on nuclear marine propulsion on 7 October described an organic moderated reactor derived from the Hawker-Siddeley proposal. (See also " Origin of Species," Atomic Review, 2 October, 1959.)

Dry-Cargo Liners

The organic moderated reactor is applied to a family of nine vessels ranging from 19 to 32,000 tons displacement with capacities of 39 to 75 MW(t). The performance of the nuclear ships is compared with conventionally powered vessels of comparable characteristics in the United Kingdom to Australia service. Two alternate routes—the Suez canal and the Cape of Good Hope—have been investigated in detail, allowing for the complications arising from the need to refrigerate some portion of the cargo originating in Australia. A similar analysis was made for

the New Zealand run via the Panama Canal. The paper's conclusion is that "nuclear ships are nearly as attractive as conventional ships, and in the case of the Capetown route there is little to choose between the economics of the two families." In actual fact, the profitability per ton cargo per annum is 10 per cent higher for conventional ships than for nuclear ships when the most profitable combination of ship and route are considered, and 59 per cent higher for the least profitable combination. The implication is that nuclear dry-cargo liners will be rather sensitive to changed circumstances in world shipping. The important conclusion however is not

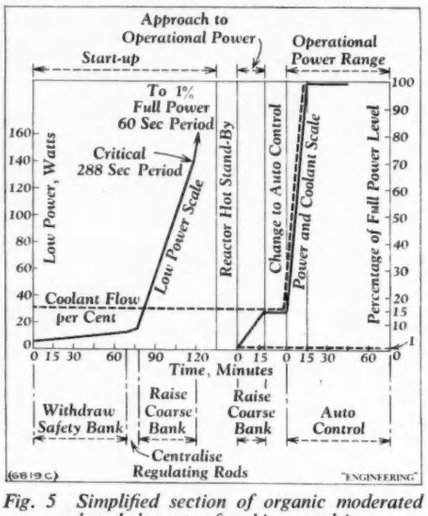


Fig. 5 Simplified section of organic moderated and cooled reactor for ship propulsion.

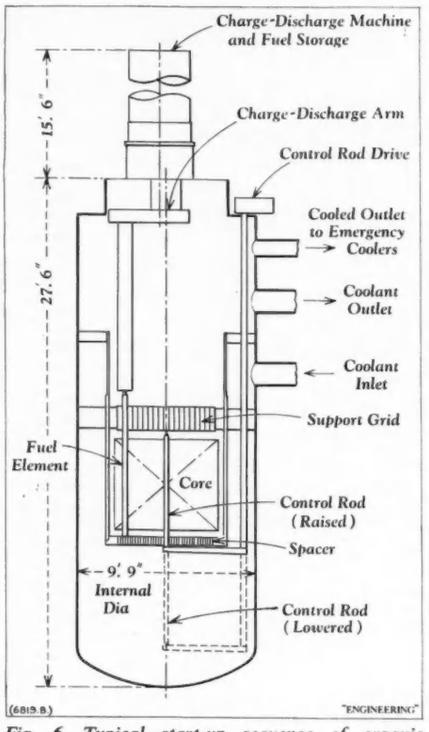


Fig. 6 Typical start-up sequence of organic moderated reactor.

that nuclear dry-cargo ships are now less profitable than conventional ones, but that it is possible to operate them today at a profit rather than with a subsidy.

Self-Contained Fuel Handling

Table II shows the specification of a 64 MW(t) reactor plant, which may be compared with that published in Atomic Review on 15 May, 1959, in connection with the Galbraith proposal. Stainless-steel clad uranium-oxide fuel rods in clusters of 19 are housed in sleeves which also form the coolant channel in the core. The fuel elements come in two equal halves to permit axial inversion. Fuel handling equipment is inside the pressure vessel and consists of the rotating and sliding members shown in Fig. 5. Up to four fuel elements may be stored in the coffin mounted on top of the reactor vessel. The components are so designed that the coffin may be removed when the reactor is on load with the minimum of service facilities. Partial refuelling at each port of call is suggested as the most economical mode of operation even though the reactor could last six trips without refuelling.

Inverted Control Rods

To permit free movement of the charging arm over a close-packed lattice, it became necessary to insert the control rods from underneath the core. Fig. 5 only shows one rod in the raised and lowered position, although three groups of control rods are provided for fine and coarse control and shut-down. The driving motors for the control rods are mounted outside the reactor vessel and transmit power through magnetic couplings. Operation of the control rods in a typical start-up sequence is shown in Fig. 6.

Heating and Cooling

Electrical trace heating of 75 kW maximum power is provided to prevent solidification of the organic moderator at ambient temperatures. The organic make-up will be carried in solid state in barrels and will be melted and added to the reactor as required. Sufficient make-up will be carried to complete a round trip to the United Kingdom, where the terphenyl moderator Santowax R is produced. A 25,000 Btu per hour cooling plant is also provided to maintain the temperature in the containment vessel at 80° F. The cooling load will be almost constant whether the reactor is operating or not owing to the decay of fission products.

Behaviour of Moderator

N. J. Swanson and D. R. Muller, of Atomics International, have reported on experience with the organic moderated reactor experiment OMRE in paper V-121 presented to the nuclear engineering and science conference in April this year. About 8 per cent of the reactor energy was absorbed in the organic liquid to produce heavy polymers, but this may be reduced to 4 per cent in low-enrichment plants. Under such conditions, the replacement need is expected to be around 100 lb per MWD of operation, or 6,400 lb per day at full power. The figure of Table II (30 lb per MWD) is considerably less than expected by Swanson and Muller (100 lb per MWD), and somewhat less than submitted to the Galbraith committee (about 35 lb per MWD). The terphenyl purification plant for the removal of heavy boiler residue will consist of a still which will be operated to maintain the polymer concentration in the primary circuit at 30 per cent. The polymer is held in the containment vessel for 24 hours to lower its activity, after which it is transferred to storage tanks in the ship's hold. The experience with OMRE suggests that the moderator activity will be mostly in inorganic impurities and the activity level is expected to drop quite rapidly.

TABLE II.—*Specification of Plant*

Core	
Maximum heat output (including overload margin)	64 MW
Core height	5 ft
Nominal core diameter	5·75 ft
Number of fuel channels	290
Number of fuel rods per channel	19
Fuel	UO_2
Enrichment (initial), per cent U235	1·6 to 1·8
Canning	Stainless steel
Uranium inventory	7·9 tonne
Average rating	8·1 MW per tonne
Average burnup	10,000 MWD per tonne
Number of control rods	19
Primary circuit	
Composition of moderator-coolant	Terphenyl plus 30 per cent polymer
Inlet temperature	295° C (563° F)
Outlet temperature	341° C (646° F)
Operating pressure, maximum gauge	90 lb per sq. in
Coolant flow, maximum	1,294 lb per sec
Pumping power	322 b.h.p.
Terphenyl make-up rate	1,050 lb per day at full power
Number of primary circuits	2

Notes and News

Dounreay Delays

The latest delay in starting up the Dounreay fast reactor is attributed to impurities in the sodium potassium coolant. As explained in Atomic Review last 13 March (p. 335), any oxygen in the primary, coolant circuit, no matter how few parts per million, will react damagingly with the niobium fuel canning. It appears that the coolant, which must of course remain liquid during loading and ever afterwards, was contaminated from a thin oxide film on the inside of the stainless steel coolant mains, so that potassium and sodium oxides in minute but more than permitted quantities were formed in the eutectic. To exclude oxygen during loading, the operation is carried out under a blanket of nitrogen gas. Tests are understood to have taken place to investigate whether cleaning of the coolant circuits is now satisfactory. With luck, the reactor may still be started before the end of the year. The main problem that still remains is the difficulty of continuously monitoring the oxygen content of the primary coolant.

Calculated Risk

Insurers from 13 European countries attended a conference on nuclear age risks arranged by the British Insurance (Atomic Energy) Committee, a pool of United Kingdom insurance companies and underwriters. The conference was the second of its kind, one having been held in February, 1958. Agreements were reached on questions of premium rating, the division of liabilities between manufacturers of reactors and the suppliers of parts, hazard valuation and surveying.

Regulation of Nuclear Ships by 1968?

Mr. J. Brown, in his presidential address to the Institution of Engineers and Shipbuilders in Scotland, indicated that regulations for the safety of nuclear-propelled ships are at present under study for possible incorporation in the programme of the expected 1960 convention.

Reactors of USN Enterprise under Test

Two prototype reactors of the proposed eight that will form the power plant of the aircraft carrier Enterprise are now undergoing tests to study their parallel operation when driving the same shaft.

Natural Circulation Propulsion Plant

Boiling water reactor plants may be simplified by the use of natural circulation. The increased operating reliability resulting from the absence of circulating and control equipment is of particular importance in ship propulsion plants. The Knoll's Atomic Power Laboratory, operated by GE, has been assigned by the USAEC to study and develop the concept.

Contract Placed for American Gas Cooled Reactor

The USAEC selected the H. K. Ferguson Company as civil engineering contractor to the experimental gas-cooled reactor project, previously reported in Atomic Review on 5 June of this year.

First Jason in Operation

The first prototype of the 10 kW Hawker Siddeley research and training reactor Jason is now operating. The company expects to sell the model to universities and researchlabo ratories for about £55,000. Atomic Review reported on Jason on 10 April, 1959 and 6 March 1958.

Hawker Siddeley Laboratory Plant

It has been announced that Hawker Siddeley Nuclear Power Company Limited, have received contracts for the design of a glove box and vacuum melting furnaces from the United Kingdom Atomic Energy Authority.

First Reactor in Africa

Lovanium University, in the vicinity of Leopoldville, Belgian Congo, is the home of the African continent's first nuclear reactor. Construction of the reactor was commissioned by the Congolese Consultative Committee for the Peaceful Uses of Atomic Energy in 1958. The 10 MW(t) solid homogeneous-fuel research reactor, one of the TRIGA series, was supplied by General Atomic Division of General Dynamics, and is the same reactor that was operated at the 1958 Geneva conference. The reactor core consists of aluminium-clad elements containing a homogeneous mixture of 20 per cent enriched uranium and zirconium hydride, submerged to a depth of 16 ft in a pool of water. Installation of the reactor is regarded in the Congo as a gesture of reciprocation by the United States for the war-time supply of 1,000 tons of uranium from the Belgian Congo, which enabled construction of the first reactor in America in 1942.

Weapons Appointment

Mr. S. A. Hunwicks has been appointed director of Atomic Weapons (Development), Ministry of Supply. His previous position was superintendent of projects at the Royal Aircraft Establishment.

Highways to Prosperity

The outlook of the manufacturers of heavy road vehicles is now better than it has been for some years. Atkinson Lorries (Holdings) Limited, who are one of the smaller companies, but one with an excellent record of expansion over the past ten years, foresee a material improvement during the current year. Their chairman, Mr. W. G. Allen, said in his annual statement that he expects profits to be higher this year than last. The reduction in the company's profits for the year ended 31 March was due to lower margins brought about by "rising costs and increased competition." This year, however, the company's order book, boosted by the general industrial improvement, is better than it has been for some years.

The demand for commercial vehicles has shown an encouraging increase since the beginning of the company's financial year on 1 April. Production in that period has totalled 136,500 units, compared with 109,000 in the corresponding period of 1958. Exports also have risen and appear to continue upwards. This is of the greatest importance to a company such as Atkinson Lorries, who have spent much of their resources on efforts to provide their customers with special types of vehicles to suit their particular operating conditions. The reduction of the company's dividend from 20 to 10 per cent—"to conserve working capital"—would appear to be a wise move in the circumstances. The long-term benefits of Atkinson's policy could be considerable.

ATV at Vauxhall

Television is coming to the south bank on a site by Vauxhall Bridge, where the old Vauxhall gas works stood. The site, which was placed on the market early last year by the South Eastern Gas Board, has been bought by Associated Television for about £500,000. It is freehold and extends for some seven acres, bounded by Wandsworth Road, Bridge Approach and the Thames.

Plans are currently being prepared for submission to the London County Council. Last year the LCC refused to approve Associated Television's plans for development of the site as a headquarters and studio block but the company have now been told that, if the Minister for Housing and Local Government approved rezoning, it would be possible to agree to such a scheme on condition that the level of employment was low and office use restricted, and also that certain improvements were safeguarded.

The site is still zoned for statutory undertakings, in connection with the old gas works, but shortly the LCC are to submit to the Minister the first review of the County of London development plan which will contain amendments suggested in the light of changed circumstances.

ICI Reap Reward

The substantial increase in ICI's profits during the first half of 1959 are attributed, in the main, to "lower unit costs of production arising from fuller utilisation of manufacturing capacity and to continuing improvements in technical efficiency." Few companies mirror as reliably the pattern of national industrial activity and investment.

Group sales to external customers in the first half of the year were £18 million higher than in the first half of 1958, amounting to £250 million. This, the report states, "reflects the net effect of an appreciable increase in the volume of sales and a reduction in selling prices over a wide range of products." The increase in the volume of group sales was attributed "mainly to the higher level of industrial activity in the UK compared with 1958 and to a substantial increase in exports.

Perhaps the most cheerful feature of this report is the very large increase in trading profits, from £24·4 million in the first half of 1958 to £34·8 million. Those who have followed an expansionist policy and kept up their capital investment programme during the 1957-58 recession will find ICI's performance most encouraging.

Chrysler in Europe

American "compact" cars are making their long expected bid for European markets. With lengths down to a sober 15 ft (22 to 23 ft is a fair average for man-size American vehicles) they have a good chance of making headway in the large car European market.

The Chrysler Corporation's Plymouth Valiant will be assembled at Rotterdam from next March. Imports of complete cars will begin in January. Chrysler abroad assemble Simca cars at Rotterdam for sale in European markets. Their plant there was acquired in 1958 from Nederlandse Kaiser-Frazer Fabriecken N.V. It extends out into the River Maas and ocean-going vessels can load and unload at the plant doors.

Servicing is being tackled in the typical American manner. A new depot for spare parts installed in the company's plant at Antwerp will supply all European countries, the Middle East, and North and Central Africa. Spare parts will be shipped initially to Antwerp from Detroit, and will cover Plymouth, Dodge, De Soto and Imperial cars, and Dodge, De Soto and Fargo trucks.

Metals for a New Age

The frustrating limits imposed upon technologists by the lack of suitable standard metals, and what is being done to correct the situation, is the subject of a most informative article published in the August/September issue of the *Du Pont Magazine*. The article, entitled "Metals for a New Age," is an account of the research activities by Dr. Elbert M. Mahla of the Du Pont concern. The plans now in hand for space vehicles and more efficient atomic power plants and chemical process equipment "won't get off paper" says Dr. Mahla "until we have structural metals that will withstand higher temperatures, that won't absorb neutrons and will survive other extreme conditions."

Du Pont metallurgical research is concentrating on titanium, zirconium, chromium, niobium, molybdenum, tantalum and tungsten, all of which are high melting point (refractory) elements possessing unique high-temperature strength, corrosion resistance and nuclear properties. In Dr. Mahla's view, these will perform "as base metals in the alloys of the future, much as iron is the base of today's steel."

Information on the direction of the company's research activities is given by Dr. Mahla. In the main it is in refining forming processes for titanium and niobium, particularly metallic niobium which has sufficient strength and oxidation resistance to be useful at temperatures up to 2,200° F and is "reluctant to absorb neutrons." Today's operating engines have almost reached the upper limits of metals now in use, roughly 1,700° F.

US Shipbuilding Recovery

The possibility of a recovery in the furtunes of shipbuilders is foreshadowed in the annual statement of the American Ship Building Company. The losses sustained in 1957 and 1958 have been arrested and a small profit of $261,400 earned in the financial year to 30 June, 1959. Losses have continued in shipbuilding, particularly on Government work, but there was a recovery in the amount of repair work obtained and the bad times the company suffered resulted in changes and improvements in their organisation which their president, Mr. Edmund Q. Sylvester, said resulted "in more efficient use of manpower in all yards and departments."

Although they have no major contracts for new ships in hand, Mr. Sylvester considers that the situation will continue to improve and that the long-term outlook is encouraging. "The fleet owners," he said, "have made clear their intention of replacing and modernising their older vessels. Although only one contract for a new vessel on the Lakes has been let this year, we feel that the prospects are good as soon as the fleet owners crystallise their plans." It may well be that the upward trend in freights is not after all so far distant and that the British ship owners, though they have not said so, are thinking much as their American colleagues.

Doxford Prospects

That a sharp recovery in freight rates may be needed to keep ship yards working emerged quite plainly from the annual statement of William Doxford and Sons, whose directors consider that the high level of profits earned during the year ended 30 June is unlikely to be maintained. Doxfords, who increased their dividend to 30 per cent (compared with 25 per cent last year), are particularly vulnerable because they specialise in dry-cargo ships and medium-size tankers, whose operations tend to be very much affected by freight rates. Already they had decided not to enter into further large-scale capital commitments and are unlikely to do so until freight rates improve. The decision to increase the dividend was doubtless influenced by their very strong reserve position and by their excellent performance in 1958-59; profits before tax, at £1·22 million, were £63,000 higher than in the previous year.

The shipyards specialising in large tonnage have continued to invest heavily in new accommodation for super-tankers and other large ships, despite their shrinking order books. Charles Connell and Company, who have spent about £1 million since the war, have constructed—by merging two berths into one—a berth which will be able to take 65,000 dw vessels. The first ship to be built in the new berth is a 37,000 ton tanker for the P & O group. By developing prefabricating techniques and facilities including the installation of a 60 ton overhead travelling crane, Connell have placed themselves among the leaders of the large British shipbuilders.

Cheaper Car Hire

The demand from industry and commerce for cars on contract hire is growing rapidly and the car hire firms have shown great liveliness and enterprise in promoting this growth. One of the leading firms, Autohall Limited—who claim to be the largest contract hire organisation in Britain—state categorically that it is cheaper to hire cars than own them. They have calculated that the cost to a company of running a suitable car for its salesmen to be £234 per annum plus x, x being "the unknown and unforeseen but very real amount of expenses that keeps cropping up during the year." Few people who run their own cars would dispute that x exists.

Autohall hire out the same car for £260 a year including regular servicing tyres, AA membership, road fund tax, immediate replacement if necessary and a new car every year after 20,000 miles.

The main starting point of contract hire organisation has been their willingness to keep motorists on the road at no capital cost to either themselves or their employers. They are now asserting themselves on a competitive basis with those who own and maintain their own fleets. It remains to be seen how competitive they are with an efficient organisation but some progress has doubtless been made in recent months and more can be expected.

Scientific Films Lively and Informative

The problem of communication between expert and layman has always been very difficult and films are now emerging as a powerful tool for this task. Their potential value to industry was clearly demonstrated at the congress of the International Scientific Film Association recently held at Oxford.

Nearly 170 delegates and observers from 20 countries attended the thirteenth congress of the International Scientific Film Association which was recently held at Oxford. Great Britain had over 60 delegates, the USSR nearly 30, and some 190 films from 21 countries were screened during simultaneous sessions of the research, education, and popular science sections.

Following the practice established last year at Moscow, awards were made for the best popular science films. Diplomas of merit went to France, the German Democratic Republic, Hungary, Poland, and the USSR for some very differing types of nature film, to Great Britain for Shell's "Schlieren" (already the recipient of a British Association award at Harrogate) and to Czechoslovakia for a beautifully pictorial account of the many contributions of electrical discharges to contemporary technology.

Special commendations went to the Austrian film "Alcoholism" for its treatment of experimental material; to France for the incredible virtuosity of the filming in "The Mason Wasp" (where the original 16 mm film "blown up" to 35 mm looked as though it had been shot in that gauge; and to Czechoslovakia's "Motion and Time," for its treatment of a difficult subject. This was indeed no less than an attempt at popular film exposition of Einstein's theory of relativity. A technical *tour de force*, this combined humour with clever trick photography and a useful amount of information. Most memorable was the sequence where the little suburban train takes off into outer space to give us a demonstration of problems such as relative time, weightlessness, and other factors.

Czechoslovakia completed a hat trick by receiving the special British award for the best foreign film shown at the congress—in this case "Drops and Bubbles" a beautiful colour record of experiments with bubbles—with some useful revelations for the student new to surface tension and plenty of beauty and a little wonder for those who just enjoy seeing good films.

There is always a tendency for national entries to have a bias in one or two directions. The East German entries, as in previous years, were concentrated mainly on teaching and research films. Much of the latter was concerned with biology and zoology, but it included three sequences of research work on drop formation in quicksilver, inorganic liquids and mineral oils; some schlieren studies of shock waves using glass, water, and carbon tetrachloride as the media; and an interesting technical teaching film on dip-upset welding—comparing manual operation of resistance heating with an automatic system. Similar in purpose was a Russian film designed for higher technical institutes on the melting of active refractory metals.

In the fields of civil and electrical engineering there were three very notable contributions. It seemed a pity that the Swedish film "Stornorrfors" was not given an award. This was a remarkably dramatic account of the building of Sweden's largest power station, with some wonderful shots of drilling operations and some interesting references to technique. Thus, to speed up drilling, banks of drills were shown being operated simultaneously by remote control over a wide front. This film did not lack shrewd bits of direction too, and there was a wonderful sequence of workers opening crates of dynamite by the simple, if terrifying expedient of smashing them hard on the ground.

The second film was a beautiful account of the construction of the new electric line from Calais to Basle. Here filmcraft took precedence over technical exposition, but there was plenty to see of French technique, and one has only to compare this with a recent British film on one section of our electrification project to be convinced that the artistic film approach is the one most likely to capture popular imagination.

For similar reasons Bert Haanstra's "Glass," which won the special Soviet award at the Moscow Congress last year, made Luc Haesaert's film "Of Sand and Fire" entered this year by Belgium seem a very milk and water affair, despite some very beautiful individual shots.

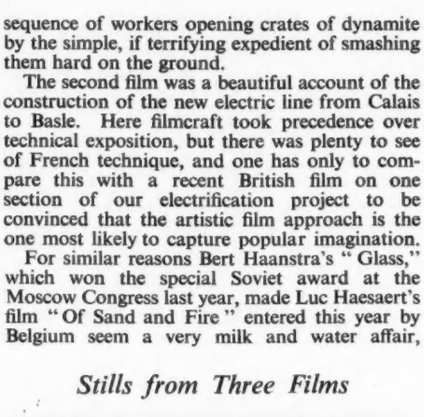
The human element in even the most advanced techniques was deliberately emphasised in the French film "Automation." This was made for Régie Renault, presumably to show to apprentices. Beautiful black and white studies of transfer machines at work, assisting in the drilling of cylinder blocks, led to a study of apprentices at work on precision parts for the control of the transfer machines. The commentary emphasised that automation, while controlling accurately many formerly manually operated machines, demands a higher standard of technical skill than ever, if it is to work effectively.

Shell's "Schlieren" was loudly applauded at the public performance in Oxford Town Hall, with its simple and clear exposition of the principles of schlieren photography and its application not only to aerodynamic research, but in more elementary and homely fields of physics. But the conquest of space has emphasised the former aspects for many of us, and it was a very attentive audience which watched the Soviet film "Quadruped Astronauts," showing the training of animals for space research. Rabbits, monkeys, birds and dogs were seen undergoing tests in pressure chambers; laboratory experiments in parachute ejection; centrifuge tests; and actual rocket launching and return to earth by parachute. It was particularly impressive to see the care and affection with which the animals were handled. On a similar theme was the Italian film "The Functions of the Labyrinths in Space Flight." This plunged with real filmic gusto into its subject—switching happily from tinted shots of some of Melies' trick sequences from his Edwardian fantasy "Voyage to the Moon", to X-ray shots of the blood being drained to the lower abdomen in a monkey in a centrifuge test, to studies of human subjects being rotated on chairs or whirled in a centrifuge. This film made the interesting suggestion that deaf people might make the better astronauts, because their defect rendered them immune to some of the nauseous consequences of high *g* forces.

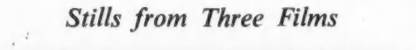
Another very interesting Italian contribution was Tosi's "Synchrotron." This was an account, for lay audiences, of the working of this machine, and the producer overcame the handicap of having to photograph something which revealed no movement whatsoever but depended on stupendous velocities for its results, by superimposing animation on live cinematography. One sequence in particular was memorable—showing the acceleration of particles around the tube of the "doughnut" by superimposing streaks on a well-lit study of the interior of the accelerator. These streaks seemed suddenly to appear from behind; an almost 3-D effect achieved by clever animation. Other films on the theme of nuclear physics were the Belgian "Nuclea" showing some of the work on the peaceful applications of nuclear energy at the research station at Mol; the Italian film "What is the Atom?"; and the Soviet film "The Atom Helps Us" showing the use of radioactive isotopes for increasing crop yields.

There were two very interesting British Contributions in the research film section. J. C. Needham repeated the very competent performance which he gave at the recent High-Speed Photography Conference at Queen Mary College by showing his film on the photography of self-luminous objects, with some beautiful shots of metal discharge during welding. John Hadland, well-known high-speed photographer, gave a typically vigorous and humorous paper, with the interesting information that whereas four years ago nearly all the high-speed cameras in this country were engaged in weapon research, now more than as many again are being used on industrial research projects, from studies of combustion in diesel engines to work study in the hosiery department of a multiple store.

Stills from Three Films



Pioneer work on radio astronomy in Australia.



Demonstrating farming machinery to local farmers.

The effect of a shockwave on a beam of light, as obtained by schlieren photography.

Wind Tunnels for Automobile Research

Research into the aerodynamics of automobiles is now being extended to a wide range of vehicles, including the ordinary family car. The Motor Industry Research Association is to build two special wind tunnels to carry out this work.

Within recent years the aerodynamic aspects of vehicle operation have become of increasing importance to the designer. This fact has now been signalised by a decision of the Motor Industry Research Association to install special wind tunnels at their laboratories at Lindley, Warwickshire. This decision marks the culmination of two years of preliminary studies by MIRA, during which tests were carried out on full-sized cars, both in a wind tunnel and on the road, and on model cars in small wind tunnels, the object of these tests being to determine the most suitable apparatus for investigating the anticipated aerodynamic problems of the industry.

The ramifications of this subject are extensive. The increased speeds of modern cars give rise to the question of drag and of the access of air to the brakes for cooling purposes. They also raise the question of the effects on stability due to winds striking the car at various angles. Even if maximum speeds were to remain moderate, however, such problems would not lose their significance. Drag, for example, which is the aerodynamic force opposing straight-ahead motion of the vehicle, will always be of interest for its effect on fuel economy; and if body shapes were to alter, with the object of reducing drag or in accordance with styling changes, this might affect the cooling of the brakes, so that a compromise solution to the problem has to be found.

In addition to the foregoing, there are several problems with an aerodynamic aspect which recur from time to time as new designs of vehicle are produced. These relate to the flow of air for cooling the engine or transmission system; the flow of air to the engine induction system (which affects power and should be directed so as to prevent the possible entrainment of dust or other airborne matter); the flow of air for ventilating or air conditioning of the passenger compartment; possible extractor effects of air currents on the exhaust system; the impingement of dust, mud, insects, etc., on the outside of the car; and the intensity of wind noises as influenced by body shape or fittings. From these examples it will be seen that the aerodynamic characteristics of the vehicle can affect its safety, running economy, durability and comfort; and it will be appreciated that in a subject of this kind there are no generalised solutions that can be applied to these problems as they arise in evolving new designs, so that continued experimental work is necessary.

In order to decide on the most suitable equipment for installation at Lindley, MIRA have done exploratory tests on full-sized cars in the 24 ft wind tunnel of the Royal Aircraft Establishment at Farnborough, on scale models in the 5 × 4 ft wind tunnel of Sir W. G. Armstrong Whitworth Aircraft Limited at Coventry, and in the 8 × 6 ft tunnel of the College of Aeronautics at Cranfield. Three full-sized cars and their corresponding models were used in these tests. In the case of the full-sized cars a comparison was obtained between drag coefficients measured in the wind tunnel and on the road. The road tests were limited to the measurement of drag, but the wind tunnel tests covered drag, lift and side forces, rolling, yawing and pitching moments; all these quantities being measured both in relation to a head wind and at different angles of yaw to simulate cross-wind effects. Road tests have serious limitations, being suitable apparently for drag measurements only and even then being dependent on the weather and on the use of a complete and roadworthy vehicle. The conclusions in fact that emerged from these investigations were that the use of a model tunnel would be economically sound for testing in the early design stages of a car, but that a full-sized tunnel was essential in the final stages of prototype development.

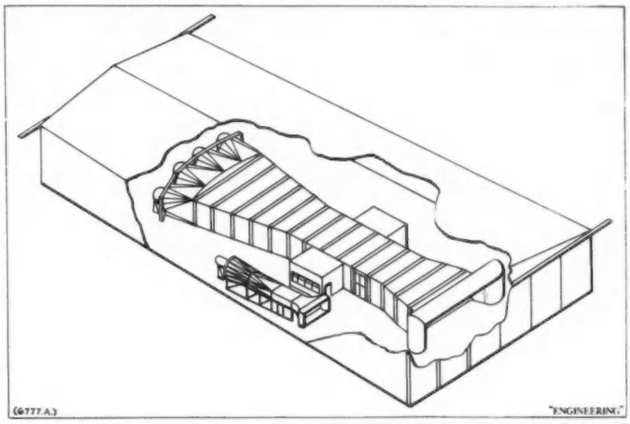
Considering these conclusions and the fact that the kind of equipment visualised would involve a substantial outlay of capital for its construction, it seemed logical that a central organisation like MIRA should install this apparatus for the benefit of the motor industry as a whole. They therefore decided that two tunnels should be constructed in a large hangar on the proving ground, one for testing models and the other for full-sized cars and light vans. The perspective drawing, Fig. 1, gives an impression of the two tunnels as they will finally be installed. They are both of the open-return type in which the air ejected at one end returns slowly to the entry through the surrounding building. The closed-return type, in which the air is continuously driven round in a confined circuit was also considered but was rejected on the grounds of its high capital cost. It is proposed to construct both tunnels of a wooden framework lined with plywood. Wood is inexpensive, light in weight and easy to work, and, in addition, its natural damping properties provide a safeguard against vibrations of the structure.

The large tunnel will have a flared entry leading to a section with parallel sides in which is set a straightener of honeycomb cross-section. This leads to a contracting section before entering on the working zone which has parallel sides. The dimensions of this part are: width, 26 ft; height, 14 ft 6 in; and length, 50 ft. Into the floor of this working zone will be set a balance for measuring air loads on the vehicle under test and also a chassis dynamometer which, by absorbing power delivered at the wheels, would enable such quantities as the efficiency of the cooling system to be determined at different engine loads and rates of air flow. The air speed will be variable in eight fixed steps between 20 and 80 m.p.h. After passing the working zone, the air will be slowed down in a diffuser and finally withdrawn from the tunnel by four fans working in separate ducts. The fans will each be driven by a separate electric motor, and the motors will collectively develop 1,300 h.p. at the maximum air speed of the tunnel. Fig. 2 shows this tunnel in plan view.

The small tunnel, also shown in Fig. 2, is intended to accommodate models of sizes up to one-quarter that of corresponding full-sized vehicles. Its working zone will have the following dimensions: width, 6 ft 9 in; height, 3 ft 4½ in; and length, 12 ft 6in. It will have similar layout to that of the large tunnel with flared inlet, a honeycomb straightener set in a short section with parallel sides, a contracting section leading to the working zone of rectangular cross-section, and finally to the diffuser and single extractor fan. The air speed will be continuously variable between 20 and 90 m.p.h., with a power requirement of 50 h.p. at the maximum speed. In choosing this maximum speed for the model tunnel, it was considered that on a ¼-scale model, having $\frac{1}{64}$ of the volume and a frontal area 1/16th that of the full sized version, the aerodynamic forces would be four times greater in relation to the model weight, assuming the same air speed and density. The problem of measurement was thus eased.

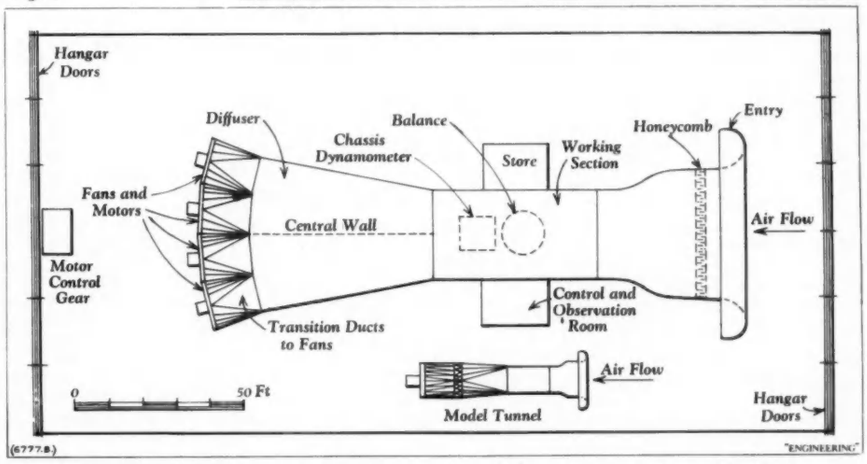
The whole project is expected to cost about £65,000 and to be completed during 1960.

Fig. 1



Plan and cut-away view of two wind tunnels to be installed at the Motor Industry Research Association laboratory at Lindley, Warwickshire. The larger tunnel will be equipped to carry out tests on full-sized cars and light vans.

Fig. 2



ENGINE NOISE

Diesel Engine Exhaust Level Reduced

Studying the manner in which various engine noises are generated, and investigating means of reducing them at source, has been the subject of considerable effort at the laboratories of the British Internal Combustion Engine Research Association recently. It is their belief that this technique will, in the long run, provide cheaper solutions to the problem than the use of various types of silencers.

The action following a single discharge of gas from a cylinder into an exhaust system has been studied, using various types of pipes and exhaust chambers. Results so far have suggested several unforseen actions affecting the noise and these are now being explored in the hope of finding effective means of reducing noise.

In considering a member's problem, connected with the exhaust noise of locomotive diesel engines, the laboratory suggested that a long-term solution to the problem of reducing the low frequency noise component would be the use of the capacity type exhaust manifold. This has already proved successful in tests on naturally aspirated engines. The use of such a manifold in the turbocharged engine means using the constant-pressure system instead of the pulse system. Further development of this system is necessary before it can be generally applied.

Assessment of the exhaust noise with such a system has been made during the course of pressure charging tests on a four-cylinder Ruston 4VRH engine of 4½ in bore and 5½ in stroke. A compound system of charging was employed in which a BSA turbocharger fed air to a BICERA compressor. A simple rectangular capacity chamber was attached directly to the cylinder head and the turbocharger was mounted on the end of this chamber, no other exhaust silencer being used. Measurements at a standard position (namely 3 ft from, and at the level of, the vertical exhaust pipe exit) with the engine running at 1,400 r.p.m. 135 lb per sq. in b.m.e.p., showed an r.m.s. level of 96 dB and a peak level of 99 dB; which is considered low for a measurement so close to the exhaust exit. Assessed by ear the noise was described as quiet.

FASTER DATA PROCESSING SYSTEM

Low-Priced Transistorised Unit

Using their extensive background of computer experience, the research division of IBM(UK) Limited, Wigmore Street, London, W1, is now developing a new range of transistorised data processing equipment. The latest of these to appear is the IBM 1401.

Intended mainly for smaller " businesses," the 1401 nevertheless reads cards at a rate of 800 per minute and prints at a rate of 600 lines per minute. The IBM 1401 Data Processing System, to give its full name, has a stored programme versatility and logical power similar to that of large computers; but its price can be compared with that of an ordinary punched card machine.

Basically the system consists of three units, fitting into an area of about 300 sq. ft. These units read at 800 words per minute, process at computer speeds, print at 600 lines per minute and punch cards at the rate of 250 per minute. To this system can be added up to six magnetic tape units, each giving a transfer rate of 62,500 characters per second.

A unique feature of this machine is its method of printing. This uses a precision made chain of engraved type faces, operated by electronically timed hammers to allow high-speed printing without loss of alignment quality. A high-speed skip, over unused sections of forms, gives an output performance equivalent to that of a conventional printer operating at 4,800 lines per minute.

GIANT HIGH VACUUM TANK

Attempts to take the guesswork out of missile design have lead to the development of a number of useful engineering devices. Latest of these to appear is a vacuum tank in which sizeable component assemblies may be subjected to ultra-high vacuum, simulating the conditions that exist some 400 miles from earth.

For the past two years the National Research Corporation, Massachusetts, USA, have been studying the expected behaviour of materials in space, using large tanks of their own design. This, their latest vacuum tank development, is believed to be unique in its combination of size and final vacuum. Its total capacity is said to be 45 cu. ft, having a 3½ ft diameter sealed door through which components of up to 4½ ft length can be loaded. It attained pressures in the 10^{-8} mm Hg range within two hours of starting and has reached a final vacuum as low as 8×10^{-10} mm Hg. Pressures in the range zero to 9×10^{-9} mm Hg, which are roughly equivalent to a 400 mile altitude, can be maintained for extensive periods.

Provision is made for numerous electrical and mechanical connections to the vacuum chamber. These are used to obtain data and to carry out research operations when the tank is sealed-off. The stainless steel system can be modified to permit introduction of thermal radiation and can be adapted to carry out emissivity and various mechanical tests under conditions of ultra-high vacuum.

NUCLEAR MASER MAGNETOMETER

A prototype model of a magnetometer, which is capable of detecting a variation of one part in a million of the earth's magnetic field, has recently been demonstrated in the United States. Known as a nuclear maser magnetometer, it was developed at the Centre d'Etudes Nucleaires de Saclay, France.

The nuclear maser is said to use the hydrogen nuclei in ordinary water as its operating substance, working at a frequency of the order of 2 kc/s. It operates at room temperature. It is claimed to have two clear advantages over other types of precision magnetometers in use at the moment; (1) it is a continuous-wave, rather than a pulsed, device and is thus instantly active; (2) the signal-to-noise ratio of the prototype model is about 20 times better than " non-nuclear " magnetometers.

With further development it is believed that this device will attain a considerably better signal-to-noise ratio and, consequently, an exceptionally high value of sensitivity.

The research which led to the development of this device was initiated for two main reasons : for a better understanding of the physics of solid-state and to obtain polarised nuclei targets for nuclear physics. The research team have been awarded the French Prix de la Recherche Scientifique, given annually for scientific research leading to an important development or device.

SLOWING MOLECULAR BEAMS

Work is being carried out at several centres to find means of slowing down the molecular particles in beam maser devices. The object of this is to keep the emitting molecule in the cavity field for a longer time. Since the molecular line width is the Fourier transform of the time pulse of the molecule traversing the emission field, it follows that a longer time gives a narrower line, resulting in a more stable maser.

A possible technique for slowing down molecules has been offered by Professor N. G. Basov, of Lebedev Institute, Moscow. This uses an electrostatic field mirror which reflects slow moving molecules back to the cavity radiation field while at the same time allowing the faster ones to go through.

AUTOMATION OF COMPLEX PROCESSES

Formation of Systems Engineering Group

De Havilland Propellers Limited, producers of Firestreak and prime contractors for Blue Streak, have now formed a Systems Engineering Group which will apply the experience gained on these and other projects to the automatic control of all kinds of industrial processes.

The new group will place particular emphasis on the design of integrated systems and it is here that the comparatively new techniques of system engineering will be used. Wherever necessary they will be backed by digital computer investigations to ensure the optimum design at any level of complexity. There are believed to be many industries which could make use of automation and the System Engineering Group is already holding discussions with the oil refining, chemical, food, brewing and paper industries.

Use will be made of the advanced electronic techniques that have been developed by the parent company. Digital systems will be used when possible, to yield accuracy, simplicity and low cost. Most designs will incorporate transistors and ferrites, which have favourable dimensions and power requirements and which are believed to be more reliable than many of their conventional counterparts. An example of equipment making use of these techniques is a large automatic data processing and logging system which the Propeller Company has recently brought to an advanced state of development.

The System Engineering Group will be located at Hatfield, in its own premises adjacent to the Propeller Company's head office. The technical team will consist of Mr. R. J. Perdue, chief designer of de Havilland Propellers, Mr. M. James, a senior electronic engineer, and Mr. R. A. Rubenstein, a senior mechanical engineer.

HEAT TRANSFER AT HIGH GAS PRESSURES

The work described in the article " Heat Transfer at High Gas Pressures," which appeared in the issues of 2 October and 9 October was initiated by John Brown Land Boilers Limited as part of their research and development programme. The work was coordinated by a committee under the chairmanship of Sir Harold Hartley. The members of the committee are Dr. A. W. Still and Messrs. D. R. C. Guttery, C. H. Secord, T. P. de Paravicini and M. Turner.

On the Shelf

By Frank H. Smith

No price appears to be attached to the Lending Library Unit's (LLU, DSIR, 20 Chester Terrace, London, NW1—HUNter 8361) " List of Current Periodicals Received from China." It is not only a list *per se* but is preambled by a lot of interesting notes about availability and so on. Being a duplicated list it must be typed, and as Chinese character titles are given as well as the transliteration the typist must have quite a lot of fun.

The *LLU Translations Bulletin* (HMSO) for September opens with an article on " Machine Construction in China," which is certainly a new use for ceramics. The second article should interest some of my kidney—" Measures for Improving Scientific and Technical Information and Propaganda "—though some of them may look down their noses slightly at the use of that last word.

A list of the autumn film releases of their industrial section is available from Central Film Library of the Central Office of Information, Government Building, Bromyard Avenue, Acton, London, W3.

As though there were not enough gravity in the world already (I'm anti-gravity myself) the Cambridge University Press are in the throes of *The Correspondence of Isaac Newton* for the Royal Society. Volume I for 1661-75 about due is seven guineas. Volume II, 1676-1688 (due in 1960), will be the same price, as will Volume III (also 1960), covering 1688-1694. Three more volumes and one of addenda and index will be announced later. Isaac must have been quite a letter writer—and no typewriter either.

I appear to be a bit late but here I have No. 6 of Vol. 3 of *Communications*, from the International Society of Aviation Writers. If any of you need to know more—25 Farmcote Road, Don Mills, Ontario.

A leaflet issued by Esso (36 Queen Anne's Gate, London, SW1) gives a brief history of their EATO 35 (Esso Aviation Turbo-oil) but I really mention it because it gives illustrations of the fifteen engines which were tested with this oil. An interesting chart of modern aircraft propulsion.

A fourth part is now available of the American Society of Testing Material's (1916 Race Street, Philadelphia 3, Pa.) *Index to the Literature on Spectrochemical Analysis* covering 1951-55. $6·50 is the price for 1879 references.

The Autumn Term *Bulletin of Special Courses in Higher Technology* of the London and Home Counties Regional Advisory Council for Technological Education (Tavistock House South, Tavistock Square, London, WC1) is now available at 3*s* 6*d*. If you order the year's two parts you get them for 6*s*. This bulletin indicates " special advanced courses held in the London and home counties which do not regularly appear in college calendars . . . as part of a grouped course or as subjects offered for endorsement " on Higher National Certificates. Eight small-print pages list the subjects available.

Do *you* want an Index Vocabulorum Quadrilinguis—on paint? It's not one of those things where you look at an index and then choose a code-word and back to the main body of the work. Each language is taken in turn as the first column, which saves a lot of time but takes more space and therefore probably costs more money. Anyway, £9 10*s* and published by Vereniging van Vernis- en Verffabrikanten in Nederland, Scheveningseweg 2, Den Haag. J.J. Raaff is the author.

I read that a new £250,000 library to be built in Norwich will have easy chairs and coffee-making facilities. We can now expect a counter-blast from ladies' hairdressers with open access bookshelves.

TAKE A POWDER

Fine Particle Measurement. By CLYDE ORR, JR. and J. M. DALLAVALLE. *The MacMillan Company, 10 South Audley Street, London, W1.* (73*s* 6*d*)

Man has used powders since the first flour was milled, and it is not surprising that many techniques have been developed to classify particles according to their properties in practical use. In the last 30 years or more, serious attempts have been made to relate these properties to the basic geometry of the particles. To do this requires knowledge of the distribution of size and shape of the particles and corresponding information about their internal pores, in which the active surface is usually situated.

This book is an extension and amplification of the chapters on particle size analysis and the determination of surface area from DallaValle's well known *Micromeritics*. After an initial chapter of definitions the methods of particle size analysis are outlined in five chapters. The first deals with the direct methods of sieving and optical or electron microscopy, the second sedimentation and elutriation, and the third discusses inertial methods including centrifugal and impaction devices. All these methods can give, at least approximately, the distribution of particle size; two further chapters on radiation scattering (that is, light, X-rays or electrons) and on gas permeability methods give techniques by which an effective diameter can be found but the distribution is deduced only very indirectly. The subjects are treated adequately except for the microscopic methods, where no mention is made of the modern flying spot scanning techniques, though some papers are quoted in the bibliography. The statistics of microscopic counting are dismissed rather cursorily, and somewhat pessimistically. It is possible to make use of the fact that the cumulative size curve seldom changes slope abruptly between adjacent size classes, in order to reduce the number of counts necessary in each class.

Each method of particle size analysis is applicable over a range of particle size, and is at its best in a somewhat narrower range. For example, sieving is appropriate above 50 microns and electron microscopy below 1 micron. A table summarising the practical limits for each method would have been very helpful.

The last third of the book describes methods of measuring the volume and distribution of diameter of pores inside the particles. A very full account is given of gas and liquid adsorption methods of measuring total surface area. When the pores in the particles are much smaller than the particle diameter, it is easy to distinguish between the external voids and internal pore space, but the author passes rather too easily over the distinction in practice when the powder has a wide particle size distribution.

A number of methods are quoted for obtaining pore volume, mean pore diameter and distribution of diameter. The exact meaning to be attributed to " diameter " and the influence of double curvature of pore walls is not discussed in any detail.

Of the methods described in the first part of the book, only the electron microscope gives a measure of particle diameter independent of internal surface when the diameter is below 1 micron, and from the second part of the book, only mercury penetration is applicable for pores much larger than 0·03 micron. This lack of overlap of methods is a weakness of present day techniques rather than of the author who is reporting them.

The book is an excellent introduction to the subject, but it is not a working manual. The bibliography is very full, about 600 entries, and given good library facilities, a reader can quickly find how others have struggled with these aspects of the obtuseness of nature. No particularly difficult mathematics are employed in the theory as printed; though there is plenty of meat in the results quoted on radiation scattering, for those who like such a diet.

The subject index is somewhat short, so that some second sight is required. For instance, the mercury porosimeter is found under " Pore size and pore distribution measurement methods —displacement ". An instructive series of tables of comparative results by different methods does something to indicate which to use in practical cases, principally in the sub-micron range.

P. K. C. WIGGS

POLYGON OF DEMOCRATIC FORCES

Labour and Economic Development. By WALTER GALENSON. *John Wiley and Sons Incorporated, 440 Fourth Avenue, New York 16, NY, USA;* and *Chapman and Hall Limited, 37 Essex Street, London, WC2.* (54*s*)

In a totalitarian state the orderly planning of economic development in a prechosen direction is—provided there are moderately ample resources—a relatively simple exercise in the techniques of management. Because of its complete command over all aspects of economic and social life, the all-powerful central state authority is able to direct the various factors of production into precisely defined areas of operation. The absence of political democracy, in its widest possible sense, enables the ruling bureaucracy effectively to smother the conflict which might reasonably be expected to arise in such a situation between those with competing demands on the economy. With but slight modification this general principle holds good for all forms of totalitarian state—whether based on the model created by the late Josef Stalin (in which economic dictatorship clothes itself with the usurped cloak of " public ownership)", or whether based on the corporate state created by the late Benito Mussolini (who in 1934 was able to say: " Three-fourths of the Italian economy, industrial and agricultural, is in the hands of the State ").

In countries where there is no firmly established state bureaucracy, or where it lacks a high concentration of economic, political and social power, the organisation of economic development becomes more difficult. There is constant tension between the major competing claims of investment requirements on the one hand and current consumer demands on the other; it is reconciling, balancing and establishing the orders of priority of these contradictory forces (contradictory only in the short term, perhaps) which presents a major task in the planning of economic development within the framework of a democratic society—and this premise holds good whether the primary inspiration behind the planning is an expressed community desire for general progress along predetermined lines or whether it is the more limited inspiration of entrepreneurs to maximise returns.

Here in Britain, as in most other industrially developed nations, the claims on behalf of the competing spheres of influence are advanced through long established and readily recognisable channels. Single industrial enterprises advance their claims in their own right and give an added sense of strength and direction to these claims through various trade and employer organisations. On the other side, consumer demand is advanced by the trade unions, primarily in the form of wage demands but also—and of equal importance—in the shape of general

policy demands, voiced through broad alliances of many trade unions, that the economy be directed along those lines most advantageous to union members and their families.

It is only in the relatively recent past that there has been any widespread acceptance of the right of trade unions to extend their functions beyond immediate negotiations on wages and conditions to the much broader task of attempting to exert a direct influence on the pattern of economic development, and even now there is a deep-seated reluctance on the part of some economists, politicians and industrialists to concede that unions have any rights outside the narrow confines of the factory walls. But, notwithstanding this reluctant and rather old-fashioned minority, trade unions now play an essential role in both the extension of democracy and the process of economic development.

Just how relevant this experience of Britain and similar countries is to the so-called "under-developed areas" of the world is a matter of more than mere academic interest. In many nations, very often those where a newly-won independence is matched by a low level of economic development and frequently by a very fragile framework of democratic institutions, the current role and future growth of the trade union movement may well mean the difference between an upward climb to a society founded upon social justice and a downward slide into some form of authoritarianism. It is the practical examination of the trade union movements in five different countries against such a background which forms the subject matter of *Labour and Economic Development*. The five countries considered are: India; Japan; Egypt; French West Africa and the British West Indies; countries which are all grappling with the comparable basic problem of stimulating rapid economic development and yet at the same time have a sufficient number of critical variables to make the essays, contributed by a number of American academics who have made a specialised study of labour economics or industrial relations, five thumbnail sketches of contrasting experiences and problems rather than a boring series of repetitions with merely changes of milieu.

It would, of course, be possible for a specialised reader to engage in debate with the authors of these essays; not so much on fundamentals perhaps, as on the relative importance which the authors attach to particular aspects of their studies. But this would hardly be fair, for, as is made clear in the book itself, the essays are intended primarily for the general reader and are but a fragment of larger studies; for those who wish to pursue the subject further there are the more detailed monographs on which this present work is based.

A fitting conclusion, which presents the reasoning of Walter Galenson, Professor of Industrial Relations at the University of California and responsible for the editing of the book, is to be found in the analytical essay which he also contributes and in which he summarises his general thesis as follows.

"Development planning under democratic auspices must accept as a major variable the growth of labour unions. These organisations are likely to be highly political and imbued with a radical ideology. They will inevitably impose some costs upon the community and reduce the practicable rate of investment. However, if properly handled, they perform the vital function of channelling worker protest into socially useful forms, and help prevent the subversion of democracy. The role of the statesman is to minimise the cost and maximise the positive attributes of nascent unionism."

Trade unionists and others will find material for argument and debate within this thesis, but it has the outstanding merit that it recognises the essential role of trade unions in maintaining democracy—a fact well worth remembering in the current "silly season" when some journalists, hard-pressed for copy, tend to grossly over-magnify minor aspects of trade unionism while completely ignoring those positive features of it which have made a major contribution to the struggle for democracy and social advance in the turbulent years since industrial capitalism began its long process of development.

BERNARD DIX

ABACUS APPLIED

Conference on Computers in the Iron and Steel Industry. Held by BISRA Operational Research Department at the Institution of Mechanical Engineers on 15 April, 1958. *British Iron and Steel Research Association, 11 Park Lane, London, W1.* (*Free of charge members, 20s non-members.*)

Issued by BISRA, the book under review is a report of a conference on computers in the iron and steel industry held in April, 1958. It was released by the publishers one year later, and a delay of this kind at a time when events are developing rapidly is unfortunate. The report itself is somewhat disorganised and in particular one wonders why the editors did not find it necessary to place their glossary of digital computer terms in alphabetical order, or at least in some pattern which would assist the reader.

Inevitably a report of this kind reflects the proceedings and standard set by the conference. Some conferences are obviously pitched at a high level, while others are pitched at a low level, depending upon the state of knowledge of those attending. This particular report is not at a particularly high level and it does not speak particularly highly of the efforts of the steel industry and of the British Iron and Steel Research Association itself, to make good use of computers.

Some of the questions asked at the conference, for example, whether the speaker really meant that a printer operated at 150 lines a minute, were elementary. In fairness, it must be pointed out that the speaker himself on this occasion made it quite clear that printers operated in fact much faster than this and that some American printers operated at 600 lines a minute, and often faster. What he did not say was that at least one 600-lines-a-minute printer had been doing this for over ten years.

As a reference book this report is of little value, insomuch that it discussed only a very limited number of computers and leaves out any mention of more important foreign installations, and much more advanced British techniques.

High Speed Computing Methods and Applications. By S. H. HOLLINGDALE. *English Universities Press Limited, 102 Newgate Street, London, EC1.* (25*s*)

The book purports to advise the educated general reader on current advances in science and engineering and then proceeds to discuss a very limited range of computers. It then enters into detail giving as an example the programming of two machines, the EDSAC and the DEUCE, both of which by the admission of the author are vintage models Furthermore, although some reference is made to the Ferranti PEGASUS computer, no reference at all is made to the UNIVAC and only a very passing reference to IBM, in connection with language translation and the building of ASCC, which was an automatic mechanical calculating machine. Nothing is mentioned about their computers.

Although the book goes into some detail on programming, it does not draw the attention of the reader to such elementary generalities as single-address and three-address programming systems. The chapters on programming in fact give the impression that this is a somewhat baffling procedure to the layman, when in actual fact the more recent computers, by means of internal initial orders and other devices, have reduced this from a coding point of view to fairly simple instructions which can be comprehended by a very lay layman.

The section of the book devoted to commerce, or rather to commercial applications, occupies five pages of a 244 page volume, while the section devoted to "fun and games" and gimmick occupations such as machine translation of languages occupies considerably more. As the publishers themselves say, the number of books on the subject of computers appears to be increasing more and more and this badly balanced book is one which would not have been greatly missed.

R. H. WILLIAMS

The Reviewers

Mr. P. K. C. Wiggs is a project leader in the central research department of the Morgan Crucible Company Limited, and was responsible for the design of the mercury porosimeter now adopted by several laboratories for pore size analysis of carbon. He is an M.A. of Cambridge, obtaining first class honours in the Mechanical Science Tripos, and is an associate member of the Institution of Electrical Engineers.

Mr. Bernard Dix is a contributor to many labour journals in Britain, the United States and Europe, and is assistant editor of a trade union journal. In 1952-53 he attended a course in trade union studies at the London School of Economics on a scholarship awarded by the Trades Union Congress Educational Trust. He is a fellow of the Royal Economic Society.

Mr. R. H. Williams is managing director of Computer Consultants Limited. He has been interested in systems applications of computers for many years and from 1956 to 1959 was manager of Remington Rand's Univac Division in Britain. He is experienced in accountancy, is an associate of the Institute of Bankers and a fellow of the Institute of Directors.

NEW BOOKS

An Introduction to Chemical Engineering. CHARLES E. LITTLEJOHN and GEORGE F. MEENAGHAN. *Reinhold Publishing Corporation, New York;* and *Chapman and Hall Limited, London.* (63*s*)

A beginning text for chemical engineering students. A year of (American) elementary chemistry and a start on calculus are assumed.

Chemistry for Engineering Students. By R. HUM. *Charles Griffin and Company Limited, London.* (45*s*)

A second edition of a 1938 textbook. The general form remains unaltered but, where necessary, revision and enlargement have taken place.

Electromagnetic Radiation from Cylindrical Structures. By JAMES R. WATT. *Pergamon Press.* (50*s*)

For a readership of antenna engineers, mathematical physicists and applied mathematicians.

Basic Geology for Science and Engineering. By EDWARD C. DAPPLES. *John Wiley and Sons Incorporated, New York;* and *Chapman and Hall Limited, London.* (76*s*)

To provide an understanding of geologic processes and sediment and rock types.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Lighthouse. STONE CHANCE LTD., Gatwick Road, Crawley, Sussex. Equipment for the Dwarka lighthouse described in publication 1/369.

Products and Services. WARD GROUP OF COMPANIES, Albion Works, Sheffield, 4. Products include cranes, machine tools, railway sidings, concrete mouldings, etc. Seventy page book illustrated in colour.

Paper Making. STURTEVANT ENGINEERING CO. LTD., Southern House, Cannon Street, London, EC4. Sturtevant air conditioning equipment, drying plants, etc., as applied to the paper making industry. Publication 4801.

Fuel Flow. SIMMONDS AEROCESSORIES LTD., Treforest, Pontypridd, Glam. Descriptions of the fuel flow test house at Treforest and its facilities and services. Illustrated booklet.

Packings in Ptfe Tolerate Rough Shafts

Fine finishes on valve spindles are unnecessary with ptfe gland rings. However, because very rough spindles give high initial friction and leakage, a ground finish of 8 to 14μ in CLA is recommended.

By T. D. S. Wood, B.A.

Technical Officer, ICI, Billingham Division

The glands of high pressure valves are often packed with chevron rings made of polytetrafluoroethylene (ptfe); the advantages of these are low friction on valve spindles, chemical inertness, and stability up to 300° C. This article describes an investigation to determine the influence of shaft surface finish on the wear rate of the rings, differences both in roughness and in type of finish (e.g. ground, diamond lapped) being considered. Tests were also carried out to compare the performance of machined and moulded ptfe rings.

A drawing of the gland block, glands and shaft is shown in Fig. 1. The shaft was reciprocated about 14 times per minute on a 1¾ in stroke by an air motor controlled by limit valves. The intergland space was filled with nitrogen at 300 atmospheres pressure. Arrangements for collecting the stuffing box and shaft leakages separately can be seen in Fig. 1; in practice it was found that there was no appreciable box leakage and so only pipes 1 and 4 were connected to gas meters. A link pivoted to the valve spindle was arranged to operate a mechanical counter which recorded the number of cycles completed.

Two types of tests were carried out:—

(1) Failure tests, in which the apparatus was run until the leakage was intolerably high. These tests were exploratory and used different numbers of rings in the glands.

(2) Fixed cycle tests. These lasted for 32,000 cycles, each gland containing three rings.

In both types of test periodic records were made of reversal counter reading, nitrogen pressure, and of the leakage readings on each gas meter. The rings were weighed before and after each test.

SEVERAL RINGS DESIRABLE

(1) *Failure tests.*—Glands consisting of 1, 2, 3 and 4 chevron rings were tested. It was found that initially the outside ring (i.e. the one at the atmospheric end of the gland) wore most rapidly, and it was deduced that this was taking most of the pressure drop. When the ring failed (usually after it had lost about 20 per cent of its original weight) there was high leakage for up to two hours and then the second ring took up the load. This usually had a slightly longer life than the first. However, resealing would only occur if the second ring was supported by a further one. Thus a gland of four rings could reseal twice, and one of three rings once, while one of two rings would not reseal; a gland of one ring had a short life and leaked badly. The number of cycles to failure of these arrangements were 430,000, 90,000, 40,000 and 16,000 respectively, indicating that it is normally worthwhile to use four rings.

(2) *Fixed cycle tests.*—Most of the tests came into this category. A uniform testing period of 32,000 cycles was chosen because in this time (about 40 hours) the glands wore sufficiently to give weight losses not seriously affected by stray factors, while allowing two tests to be completed each working week. Tests were run non-stop, and were of such duration that it was only necessary to use three rings per gland.

The ring bores were measured by means of a Solex Comparator, and only rings with bores between 0·492 in and 0·4965 in were used. The interference on the shafts (0·499 to 0·500 in o.d.) was thus 2·5 to 8 × 10^{-3} in. This tight tolerance is necessary to avoid influencing the results, and could be relaxed slightly in practice.

The bores of a typical sample of 60 machined rings were measured and 38 were found to be in the required range. Of 30 moulded rings measured, all came within the range. The moulded rings are thus to be preferred because of their more accurate manufacture.

A few tests were carried out with rings of approximately 0·512 in bore. It was found that these rings leaked for about two hours on first starting up but after this period they behaved normally.

Wear rates for machined and moulded ptfe rings are plotted against shaft roughness in Fig. 2; different symbols are used to indicate the results for the two glands and for different types of surface finish. Regression lines (the best fit straight lines) are also shown in Fig. 2. As is usual in wear experiments there was a considerable amount of scatter; the drive-end gland suffered particularly in this respect, probably because of slight vertical movement of the spindle caused by the resistance of the limit valves. The results for the different types of finish are neither consistently above nor below the general level and it appears that the type of finish has no significant effect on wear.

A sufficient number of tests has been carried out to justify the use of statistical methods on the results, and two definite conclusions have been reached:—

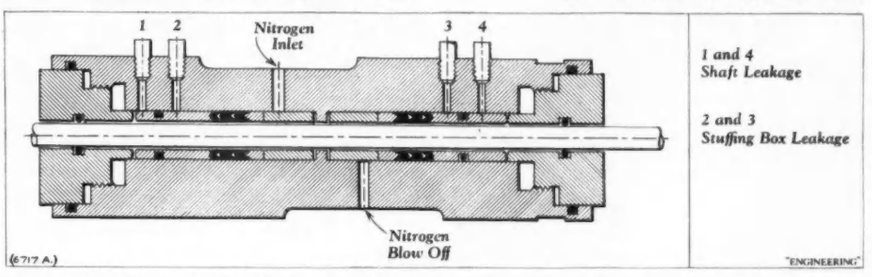
(1) that shaft roughness has no effect on wear rate. This is shown clearly in Fig. 2, where both regression lines show almost zero slopes, and

(2) that the moulded rings wore less than the machined rings. The mean wear rates and standard variations are as follows:

Machined (38 points) $W_1 = 0{\cdot}206$ $S_1 = 0{\cdot}114$
Moulded (22 points) $W_2 = 0{\cdot}116$ $S_2 = 0{\cdot}076$

These values were compared by means of the t-Test (p. 65, Statistical Methods; O. L. Davis, ICI, 1957) and a value of $t = 3{\cdot}31$ obtained. This is significant almost to the 0·1 per cent level—i.e., if the moulded rings were no better than the machined there is slightly more than one chance in a thousand that the observed results would be obtained. It is therefore concluded that a difference does exist, and that the moulded rings are slightly better wearing.

Fig. 1 Sectional view of gland block.



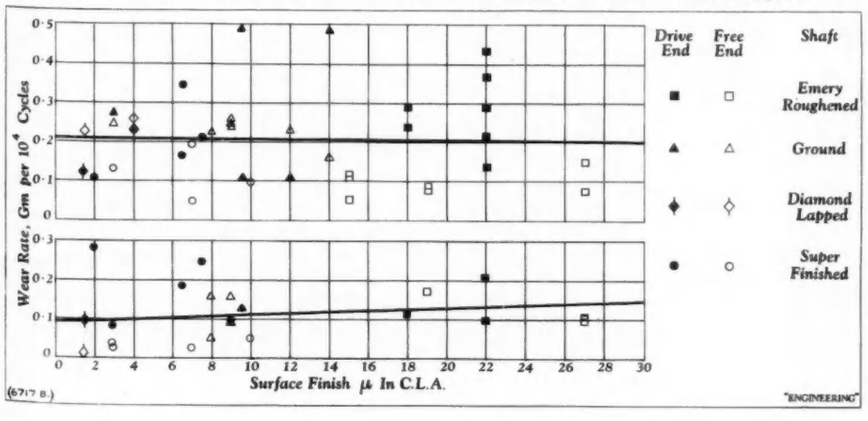
PTFE ON SHAFT

With very rough shafts ($> 18\,\mu$ in) the initial friction and leakage were high. The friction was sometimes so great that the spring of the air motor was not able to return the spindle—the spring force was of the order of 1,000 lb when compressed. Normal friction was about 100 lb and sensibly constant from 100 to 300 atm, falling off at zero pressure to about 50 lb. The technique used in freeing the spindle was to reciprocate it a few times with no pressure between the glands. The high initial friction, and the fact that wear does not increase for rough shafts, suggested that a film of ptfe forms on the shaft, giving a smooth surface. The film can in fact be seen with the naked eye on very rough shafts and tests of shaft surface replicas shadowed in an electron microscope have shown that it is also present on smooth shafts.

In conclusion, therefore, there is no advantage in going to the expense of very fine finishes on valve spindles to be used with ptfe chevron rings, but since very rough spindles give trouble with high initial friction and leakage, a ground finish in the range 8-14μ in CLA is recommended. This can be achieved on an ordinary grinding machine.

An initial interference between the shaft and rings of 2 to 10 × 10^{-3} in is recommended for ½ in shafts and *pro rata* for others. This tolerance can be more easily maintained by moulded than by machined rings; the moulded rings are also better wearing and they are therefore recommended.

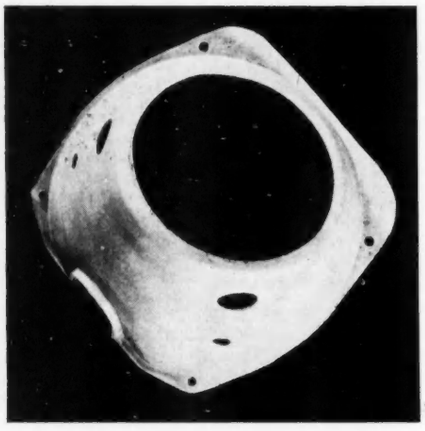
Fig. 2 Effect of surface finish on wear rates of moulded rings (lower) and machined (upper).



MOULDINGS FOR AUTOMOBILES

Hawley Products of Tottenham, London, N17, are the makers of a moulding material made from wood-pulp fibres together with phenolic resin and rubber latex. The properties can be varied by altering the proportion of these binding materials, but generally the strength is in the range 2,000 to 7,000 lb per sq. in. Among the components made in this material for the automobile industry are instrument cowls, one of which is illustrated below. These were, incidentally, shown at the International Plastics Exhibition, together with glove and oddment boxes.

Plans for exploitation of the material in this country—for Hawley are developing it together with their American associates—are far more



This moulded cowl is among the first of several applications of cellulose reinforced resin in the car industry

grand. They include rocker arm covers, engine sumps, car radio housings, door panels, and seats.

VINYL COATING RESISTS ST. LAWRENCE

A coating system based on vinyl resins was specified by the St. Lawrence Seaway Authority for all submerged and semi-submerged structures in the Canadian section of the project. The system has been applied to gates on all five locks, and to bulkheads and tainter valves. The water at all these points is fresh, for the tideway extends only up to Trois Rivières, which is 150 miles downstream from Montreal.

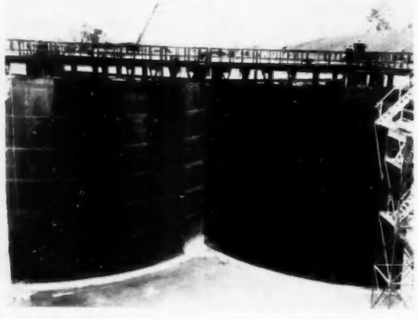
The Authority's minimum specifications were as follows:

After sand blasting, one coat of pretreatment to a thickness of 0·3 to 0·5 mils. A wash primer based on Union Carbide vinyl butyral resins was used for this.

A series of coats of vinyl primer, at least two, to build up to a total thickness of 3 mils. For this red lead based on Union Carbide VAGH vinyl resins was chosen.

Series of coats of vinyl paints, at least three, to build up to a total thickness of 7 mils, for which a black coating based on the same firm's VYHH vinyl resins was used.

The major portion of the system was applied in the shop, the balance in the field. All bolts used in the joining process were sand blasted and coated with the same system.



One of four pairs of sector gates coated with a vinyl resin paint installed in the Iroquois lock on the St. Lawrence Seaway.

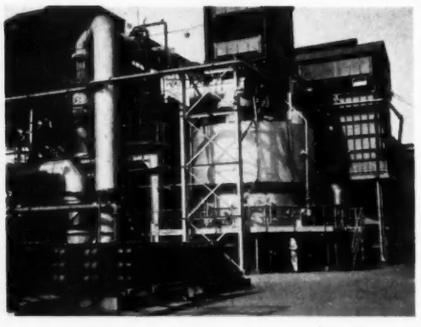
HOT TAPES

It is quite surprising what can be done with a masking tape which will withstand 180° C. Such a one is Hitem 577 which is made by John Gosheron and Company, 79 Albert Embankment, London, SE11. Although designed for such applications as masking components which are stove enamelled or infra-red dried at high temperature, it has shown that it will successfully stand up to metal sprayed at a temperature of 5,000° F. The tape, of course, remains quite cool (around 200° F) as does the rod or shaft being coated, but it is still an achievement.

The same tape has satisfied the demand for a masking tape which will withstand the severe conditions imposed by immersion in hot phosphating solutions. When applied to a trichlorethylene degreased steel tube it has remained intact and protective for 30 minutes in such a solution at a temperature of 97° C. Moreover it will withstand a typical phosphatation sequence of cold running rinses, hot static rinse, sealing and oiling.

PLANT DECOMPOSES

A chemical plant which has recently been commissioned by Chemical Construction (GB) and Dorr Oliver, will produce sulphur dioxide from the decomposition of ferrous sulphate. The site of this plant, said to be the first of its type in the UK, is at the Grimsby works of British Titan Products. The ferrous sulphate is a by-product of this works, and the sulphur dioxide will be used for sulphuric acid manufacture, via sulphur trioxide.



Ferrous sulphate is decomposed in a fluidised bed.

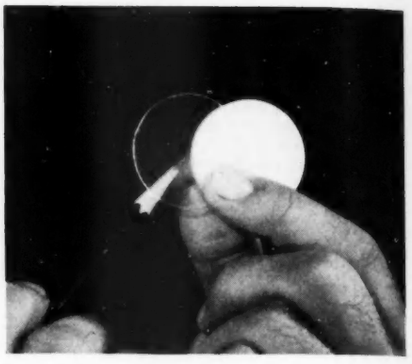
The plant, shown in the illustration, was designed and built by Chemico using Dorr Oliver Fluo Solid Reactors. In it, dried ferrous sulphate is roasted with coal in a fluidised bed.

TRANSLUCENT CERAMIC

Many advances have been made in recent years in the production of non-porous ceramics. Morgan Refractories, in the UK, are, for instance, now able to make impervious alumina and thoria without resort to the use of glassy bonding agents. This has resulted from a better understanding of the processes of slip casting and sintering by which these materials are made.

In the United States, the General Electric Company announce that they have gone one further than making ceramics impermeable, and have been able to eliminate the pores from a sintered body of alumina. The result is a crystalline ceramic which does not scatter and absorb light—similar to single crystals of ruby and sapphire.

At least 90 per cent of the light in the visible spectrum is transmitted through the new ceramic. General Electric, incidentally, call it Lucalox. It is stable at temperatures close to 3,600° F compared with 1,800° F for fused quartz. Transparent envelopes for high-intensity incandescent and discharge lamps—at present limited



Translucence results from elimination of pores.

At 2,350° F a bar of quartz bends under its own weight; the new ceramic supports a 50 gm weight even up to 3,200° F.

by the heat resistance of the envelope material—are one example where it could be used to advantage.

GALLIUM

An unusual metal called gallium, which melts in the shade of a hot afternoon at 85° F has been harnessed for high precision scientific studies by Bureau of Mines petroleum workers in the United States. The key to its use is the discovery that tantalum will resist corrosion by the metal up to the 650° F mark.

Gallium, although once called the "missing-link" metal, is actually 150 times more plentiful than silver and can be bought at twice the price of gold—a difficulty, however, has always existed in finding a container for it when molten.

In this application by the Bureau of Mines, the metal is being used to increase the accuracy of pressure-volume-temperature measurements for petroleum studies. In the tantalum container Bureau scientists predict that they can record characteristics up to 6,000 lb per sq. in. If beryllium or tungsten linings are employed it is believed that both this and the top temperature can be raised.

Alloys and compounds of gallium are now used commercially in dental fixtures, optical mirrors and for sealing joints in special glassware, but the total consumption is small.

Proteus-Powered Patrol Boat

In 1956 a contract was placed with Vosper Ltd., Portsmouth, for the design of two prototype patrol boats. Demonstration trials of one of these boats, HMS Brave Borderer, were recently undertaken.

The craft is 96 ft long and powered by three Bristol marine Proteus gas turbines, each developing 3,500 b.h.p. maximum (2,800 b.h.p. continuous), and driving through a gearbox designed and developed by W. H. Allen Sons and Company Limited, Bedford.

The general arrangement of the engine-gearbox layout is shown in Fig. 1. Transmission from each turbine is through the gearbox (including an epicyclic reduction and V drive), specially designed for the project on Allen-Stoeckit principles. Propeller shafting is of monel metal running in cutless rubber bearings located in the sterntubes, intermediate shaft brackets and main shaft brackets.

An interesting feature is the elimination of keyways and shaft tapers in the propeller bosses by a technique developed in conjunction with Skefko, whereby the propellers are expanded on to tapered sleeves under pressure. This permits a noticeable reduction in the diameter of shafting, and assists the general problem of drag reduction.

The control of machinery for reversing and manoeuvring is arranged from the bridge. In addition, there is a control instrument panel located in the action information office, from which point an engineer can supervise the functioning of the machinery as a whole. The control levers are of the "Bloctube" type, and they control the engine throttle and reverse gear control through a single lever.

Steering is through three rudders operated by an electro-hydraulic gear developed by Vosper Limited, incorporating Keelavite hydraulic rams.

The main load bearing structure is of aluminium, welded by the Argonarc and Argonaut processes. The bottom and sides are of double diagonal mahogany planking bolted to the structure. Aluminium alloy to BSS 1470, NS 5-½H was used for sheet and 1476, NE 6-M for extrusions. The bottom up to the waterline is sheathed with fibre-glass. The air intake structure is formed from a fibre-glass moulding.

At an early stage it was decided to build a full size "mock-up," complete in every detail, of the engine spaces, bridge, action information office, electrical room and wireless office. This was a necessary decision in view of the complexity of the equipment in a modern warship.

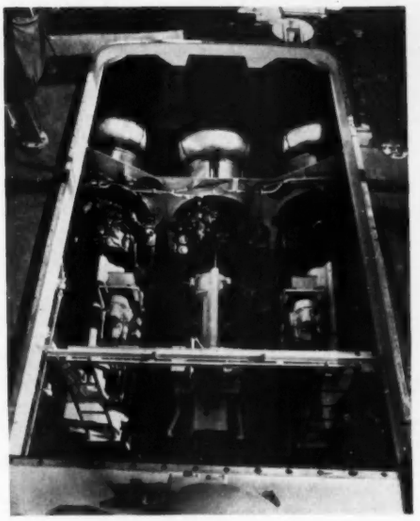
Principal dimensions: 96 ft long; 25 ft beam; 95 to 100 tons average displacement.

Speed: More than 50 knots at 10,500 total b.h.p.

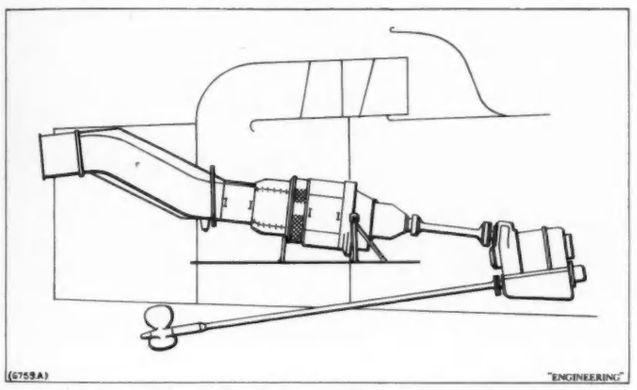
Main propulsion units: Three Bristol Proteus marine gas turbines each of 3,500 maximum b.h.p. and 2,800 b.h.p. continuous rating.

Gearing: Links the turbines to the propellers, from a special design by W. H. Allen Sons and Company Limited, Bedford.

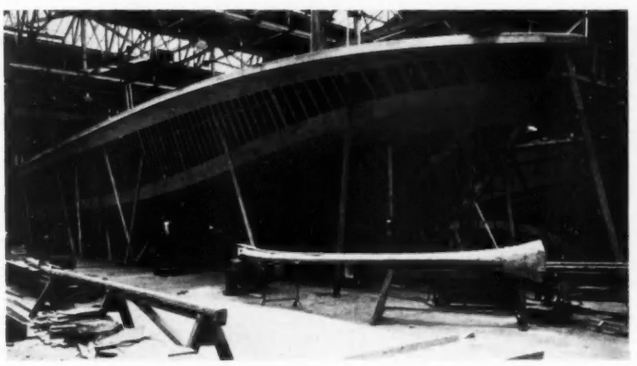
Trials of HMS Brave Borderer are well advanced and the results very satisfactory. A speed of more than 50 knots is possible. This is the first warship anywhere in the world to have such a service speed.



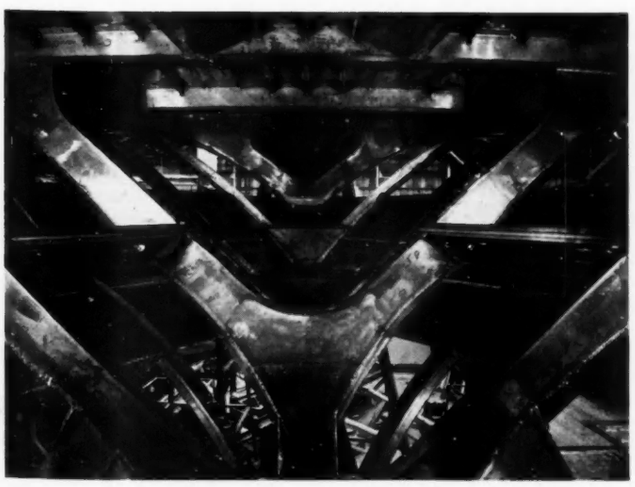
General view of engine compartment looking aft, showing the three Bristol Proteus marine turbines.



Installation of the Proteus gas turbines and the Allen hydraulically operated reverse-reduction gearing is shown in this diagrammatic drawing.



Craft under construction showing the alloy hull structure complete and ready for the wooden planking. Note the laminated timber false stem.



This view shows a typical welded joint in the structure of the fore peak.

Shown here is a typical welded joint in the structure of the fuel tank.

Versatile Tractor with Digger and Shovel

An advanced industrial tractor-mounted digger and power shovel, the MF 702, Massey-Ferguson, embodies many years of experience gained with non-farm tractors.

The MF 702 light industrial tractor provides the power for this three-in-one unit, which should be most valuable to the builder and civil engineering contractor, transport works authorities, transport undertakings and so on. It is made by Massey-Ferguson, Coventry.

By removing two hydraulic pipes and four pins the digger can be dismounted from the tractor in five minutes. The power shovel can be removed just as quickly and easily, leaving the tractor as a heavy-duty mobile power unit.

The tractor is available with (or without) an hydraulic system. A separate high capacity pump for the front-mounted shovel and rear digger is located on the front axle support and driven direct from the engine crankshaft. Front end ruggedness results from the solid non-adjustable, cast steel axle. Heavy duty king pins, stub axles, hubs and bearings help the tractor stand up to the high stresses.

Power steering is fitted as standard equipment, so that, even with a fully-loaded shovel, the steering wheel can be turned with one finger.

The tractor is powered by a 37 b.h.p. diesel engine, one that has already proved itself in the MF 35 agricultural tractor. A single plate, heavy duty, heat-resistant clutch (it has a 9 in driven plate) is fitted. This driven plate has 12 buttons of "cerametallic" sintered metal friction material, riveted back-to-back in six pairs. The pressure for the drive is maintained by 12 insulated compression springs.

A throttle, hand or foot operated, is standard equipment. The hand throttle is under the steering wheel; the pedal for the foot throttle within easy reach of the operator's right foot. By using the foot throttle the operator has both hands free to change gear and to operate hydraulic control levers for the shovel.

For maximum traction under adverse conditions on industrial sites, six-ply, 13 × 24 in rear tyres are supplied. For heavy-duty shovel work, the front wheels are fitted with eight-ply 7·50 × 16 in tyres. The MF 702 is available with either a conventional brake layout or a dual braking system (footbrake and handbrake).

The Rear-mounted Digger

The MF 710 rear-mounted digger is claimed to be the only one that can be offset for flush digging alongside an existing wall, fence or foundation. A compact, manoeuvrable and efficient machine, it has produced an output at least 23 per cent greater than competitive machines of the same size working under similar conditions, fitted with the same sized bucket.

Used with the front-mounted power shovel, it forms a composite unit for tackling a variety of tasks. It has been successfully used to dig trenches for sewers, gas mains, water lines and telephone cables; it will dig drainage channels and septic tanks and excels in digging, dredging and clearing irrigation canals and ditches.

In the building industry, the new digger proved ideal under test for opening footings and foundations in construction work. During site clearance it has uprooted trees and hedges, as well as man-made obstructions. Public works contractors have used prototype machines for road widening.

The digger has a 185° operating arc and can be operated with the tractor at right angles to a ditch.

(Left) Rear mounted digger fitted to one side of the frame.

(Right) Shows one of the two hydraulically-operated pads.

Because the digger is carried on the same subframe as the loader, the tractor itself is completely protected from digging stresses. The unit is operated by a high capacity gear type pump at a pressure of 1,850 lb per sq. in. The hydraulic systems of the digger and shovel are isolated from each other by a simple change-over valve and the digger is operated by a control bank of six levers conveniently placed for the operator, whose seat swivels with the boom of the digger. This means that the operator always faces the work, with unobstructed vision, better control and less fatigue. Two levers control independent vertical stabiliser feet, which can be used to level up the digger on sloping ground or to produce undercut excavations.

The digger boom is raised or lowered by pulling or pushing the first lever. The second lever operates the rotary actuator. Pushing it swings the boom to the left; pulling, swings it to the right. The digger arm is controlled by the third lever, which is pulled to bring the arm towards the operator or pushed to extend it.

When centrally mounted, the digger has a 185° operating arc and can dig at right angles to the tractor centre line, and so it can work in confined spaces. It has a reach of 13 ft 8 in (17 ft 5 in from the centre of the tractor rear axle) and can dig down to a depth of 12 ft. With a trench bucket fitted, there is a dump clearance height of 8 ft, which increases to 10 ft 2 in with a face shovel.

An important feature, adding greatly to the usefullness of the digger, is that the unit can be fitted to either side of the rear frame, as an alternative to the centre location. The change-over is a short job, enabling trenches to be dug close to walls and fences.

The digger can be detached from the tractor in five minutes and can be re-attached as readily. It forms its own tripod when dismounted and no special hoists or tools are needed. In transport, it folds into a compact, balanced unit.

It is equipped with double-acting hydraulic rams to ensure good penetration under the most exacting conditions. The speed of response and sensitivity of control results in an extremely high standard of work.

The pump can sustain an output of 15¼ gallons per min. at 2,000 engine r.p.m. at 1,500 lb per sq. in.

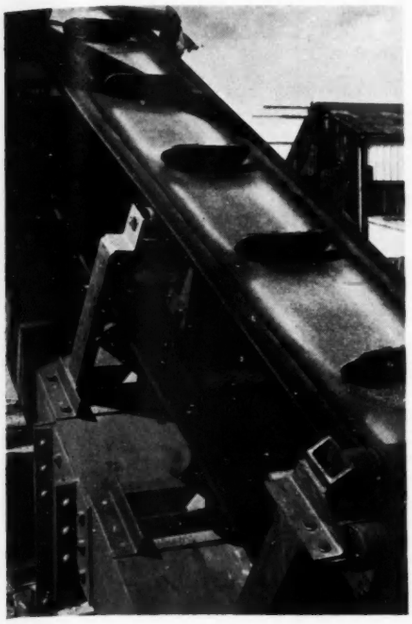
Ordinary trench and clay buckets are available in 12, 16, 20 and 24 in widths.

The Power Shovel

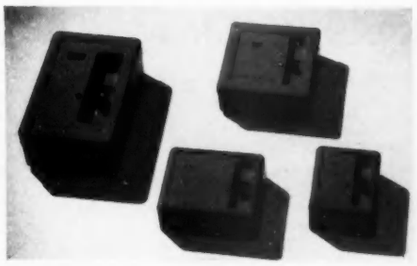
The front-mounted two-power shovel combines high output with versatility. Alternative buckets for different applications are available, together with a range of special attachments, including a fork lift angle dozer, crane and scarifier.

This versatility, coupled with the manoeuvreability of the tractor, makes the unit particularly suited for material handling and earth-moving operations in the confined spaces frequently met on docksides, building sites, in stockyards and factory premises. Working in coke and loose gravel, outputs exceeding 60 cu. yd. per hour have been obtained with the shovel, in the hands of a semi-skilled operator.

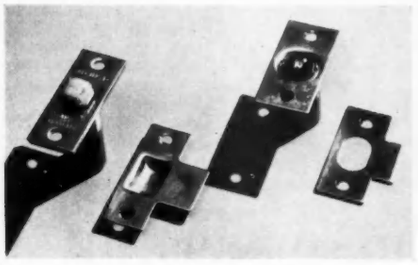
Of rigid, heavy-duty, box-frame construction, the power shovel is mounted on a sub-frame also used for the rear-mounted digger. The loader arms pivot on replaceable hardened steel pins and bushes. Double-acting rams ensure a good "bite" and positive front end control. The shovel can lift 2,000 lb at 2,000 r.p.m. on the engine with breakaway at 3,000 lb. An overall lift height of 11 ft 8 in is possible with a bucket height of 9 ft 8 in and a dump height of 8 ft 6 in.



Belt conveyor for moving granular materials when space is limited (Birtley Engineering Limited).



Silvertip switchfuses made by Revo Electric. The metal cases are of steel, Bonderised and painted.

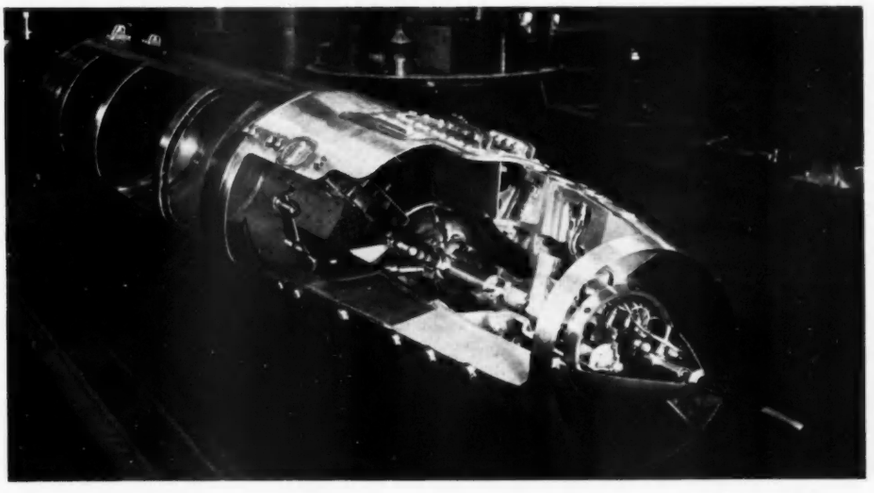


The Harrison roller catch (left) is adjusted with a coin and the Bales catch (right) with a key.

Trial rig-up of the world's first lever-lift drilling mast, supplied by Oil Well Supply Co. Ltd.

The turbine-engined Sikorski S62 helicopter, recently seen in this country for the first time, carries eight passengers. It has a flying boat hull for use on water and a wheeled undercarriage for land operations.

Hermes ceiling fitting, one of the lamps in the Olympus range of lighting fittings made by Falks.

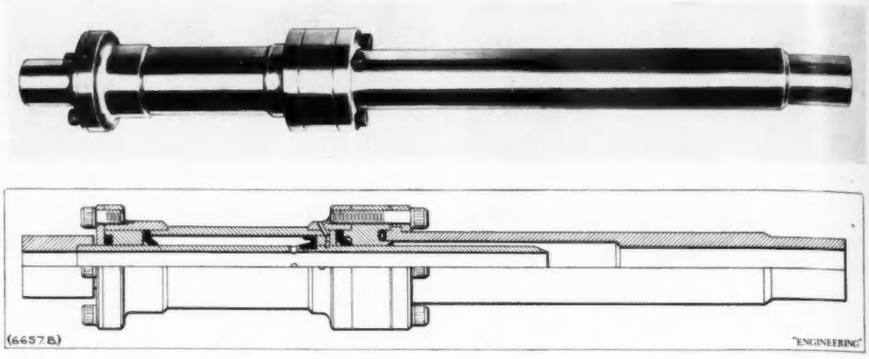


Bristol Siddeley Thor BT-1 ram jet engine. Air enters the annular intake between the nose cone and the engine casing and fuel is injected through jets. The vast energy released produces a high thrust.

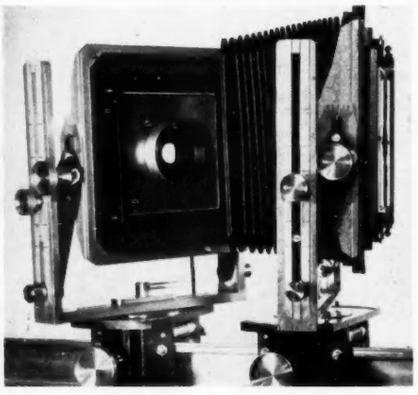
EXTENSIBLE HYDRAULIC LINK FOR HIGH PRESSURES

A device has been designed and developed by the Oil Feed Engineering Company Limited (High-Pressure Hose Division—BTR Industries Limited, Vincent Square, London, SW1) for use with their " Hi-Flex " flexible pressure pipes. It answers the direct need for large equipment to be articulated or flexed without the disadvantages of looped hoses, that might catch on obstructions. It will be useful in automation, mechanical handling, mining, and hydraulic engineering.

Basically, the extensible hydraulic link consists of a tubular member that can be expanded or contracted axially. It uses a hydraulically balanced mechanism to enable these movements to be carried out while fluid at high pressure is going through the appliance. The resistance to movement is low, so that little energy is absorbed when relative movement takes place between the end attachments. In its present form the link is designed with plain tube ends, but could easily be produced with standard male or union ends. The standard model is for $\frac{3}{4}$ in feed lines. Its overall length extended is $18\frac{1}{2}$ in and fully retracted 15 in, but this travel can be extended for special services. The designed maximum working pressure is 3,000 lb per sq. in. The unit is leak-proof and will function for long periods without seal replacement, an operation that is quite easy to carry out. Made in mild steel and plated, the component is so designed that seals and moving parts are easy to inspect and replace.



SELF-ADHESIVE URETHANE FOAM



In his industrial and professional Ardam monorail camera, Mr. Van Kan (of London) has made considerable use of Tesamoll, a self-adhesive plastics foam (Sealdraught Limited, Buckingham Gate, London, SW1). The camera is a multi-unit monorail which can be adapted from $2\frac{1}{4}$ in by $3\frac{1}{4}$ in up to 10 in by 8 in. To make the camera acceptable to the busy professional photographer it was essential to make the interchange of the various units quick and easy.

This was done by using the special feature of compressibility inherent in the open-cell structure of self-adhesive urethane foam. This has a high ratio of compression to density, so that it can be compressed easily, without exerting a correspondingly strong or increasing ratio of push-back.

This feature of urethane was made use of in the front panel unit where strips were fixed on to the rebates to receive the lens panel. In this case the lens panel is simply pushed in to compress the black Tesamoll foam seating and the holding slides pushed across. The panel and the holding are firmly held in position by the gentle push-back of the foam. Another feature of the foam, in this case, is that it ensures a perfect light-tight fit at all times, even if lens panels of slightly differing thickness are used. Self-adhesive foam is also used to seat the front bellows-panel to the front unit, and the back bellows-panel to the half-plate back. (The front panel is shown here with the bellows panel removed.)

Self-adhesive urethane has also made it possible for the manufacturer to simplify construction and eliminate much machining, special fitting and the use of metal springs. Unlike rubber, urethanes are unaffected by oxygen, ozone or light, except for a slight discoloration of the white or light coloured grades.

ALTERNATOR WITHOUT BRUSHES OR COMMUTATOR

The brushless alternator made by the Macfarlane Engineering Company Limited, Cathcart, Glasgow, S4, is an important development in electric generation, for it has no brushes, slip rings or commutators and no external control gear.

Development work on brushless alternators began about four years ago, when power semi-conductors were first introduced. At that time they could not carry enough current, and the first step was to collect information on semi-conductors and test the most promising ones. The result is this brushless alternator with its new (but well proved) electrical design, incorporating the latest in semi-conductor devices.

HOW IT WORKS

The alternator is of the revolving field, non-salient pole construction. The supply to the field is from an exciter which is in itself a small revolving armature machine. The three phase output from the exciter is led directly to rectifiers which rotate with the shaft and the output of the rectifiers supplies the main alternator field. The exciter field is supplied by a transistor preamplifier.

Control is obtained by matching a quantity proportional to the alternator voltage against an artificial " reference." Any subsequent error is amplified first by a transistor amplifier and second by the exciter. As a result, a powerful correcting m.m.f. is applied to the alternator field. The only separate item is a small hand-operated rheostat for obtaining any desired voltage within the normal range, which regulates itself at that voltage within $\pm 1\frac{1}{2}$ per cent.

The voltage feedback is obtained either from stator tappings or from the output terminals via a transformer. The resultant a.c. is rectified and the output applied to a reference circuit which incorporates Zenner diodes operating at their break-down reversed voltage condition.

The rotating rectifier unit is simple and consists of hermetically sealed silicon diodes, capable of operating over a wide temperature range, mounted on fins specially designed to promote cooling. The unit is mounted on the exciter shaft close to the incoming cooling air where its rotation blast cools it.

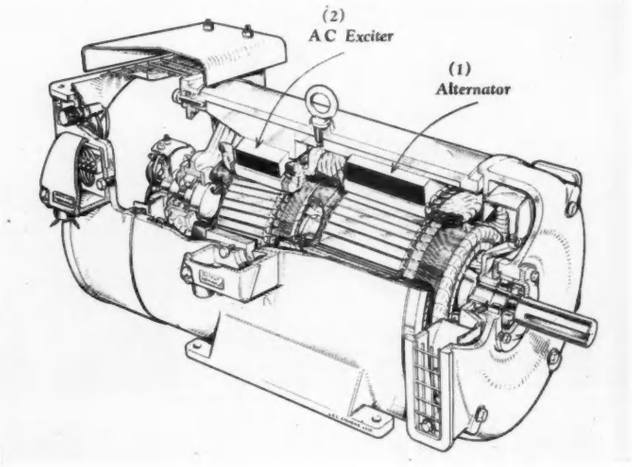
Performance

KVA rating
10 to 150 KVA at 1,500 r.p.m., 3 phase, 3 and 4 wire

Frequency
50 cycles at 1,000 and 1,500 r.p.m.
60 cycles at 1,200 and 1,800 r.p.m.

Voltage range
190/205 up to 410/440

Power Factor
Any preset value from 1·0 to 0·8 lagging.



Confusion in Measuring Surface Roughness

There is no other branch of engineering metrology where there is more confusion and misunderstanding than in the measurement of surface roughness. There are many standards for assessing roughness, though two are used predominantly. It is possible to convert from one of these standards to the other.

By M. P. Rubert, A.M.I.Prod.E.

Roughness and smoothness are clear concepts to everybody, since we practice tactile comparison from the first day of our lives. Whether we inspect articles of wood or metal, textiles or plastics, paper or leather, quite subconsciously we touch them because visual inspection alone does not give all the information we want.

Our ability to assess surface quality by tactile comparision is therefore highly developed, and no doubt very helpful in keeping the surface roughness within certain limits, without using instruments. On the other hand, it is precisely the same obvious concept of roughness which so often causes confusion and renders the whole field of surface roughness measurement ambiguous and unscientific. The difficulties in reaching international agreements on definitions and standards are probably due to the same cause. The methods we are using at present to define and evaluate surface roughness very often contradict our natural concepts of the idea (which is broadly speaking, equivalent to the frictional qualities of the surface) and this applies to all national standards of roughness evaluation.

Before discussing the various national standards we need to know the basic definitions. There are two ways of defining surface roughness. There is firstly a geometrical method which gives a numerical value to the deviation of the profile from a reference line. In this case, the original three-dimensional problem is reduced to one of two dimensions. The second definition is functional, and gives a quantitative designation to certain physical actions or effects influenced by surface roughness, e.g. pressure variation in a pneumatic circuit, reflection of light and friction. In this case, three dimensions may be explored simultaneously. Since the standardisation of instruments and their readings using the latter alternative led to innumerable problems, an international agreement was reached to adopt the former geometrical definition. (See the report of the meeting of working group R of the International Institution for Production Engineering Research in Vienna, 1958.)

The basis of the geometrical definition is the line from which the deviations are considered, and there are two possibilities at present causing considerable controversy. These are the mean or centre line, and the envelope line.

The system based on the mean or centre line is called the M system, while that based on the envelope line is called the E system. The letters M and E have been internationally adopted, but this is unfortunately the only point on which agreement has been reached with regard to the two systems.

MEAN LINE

BS 1134 defines the mean line as, see Fig. 1a, " A line conforming to the prescribed geometrical form of the profile and so placed that the sum of the squares of the ordinates between it and the profile is a minimum " and this mean line is the reference line from which the deviations of the profile are evaluated. The E system, see Fig. 1b, is based on an imaginary line, which is generated by the centre of a sphere of radius R, when it is rolled over the crests of a surface. This line is then lowered by the distance R, so that it rests on the peaks of the surface. The construction of the E line is very simple. Ordinates are drawn through the highest peaks, e.g. at A and B in Fig. 1b, normal to the ideal geometrical line. With C_A and C_B as centres circular arcs of radius R are drawn which form the E line. This construction presupposes a graph recording with equal horizontal and vertical magnification. Most instruments, however, provide only highly distorted recordings, with the vertical magnification up to 500 times greater than the horizontal magnification. Thus the circular arcs are distorted into an elliptical form. In addition, with a recording which does not distort, i.e. which gives an H : V magnification ratio of unity, but merely magnifies, the arc will appear, over a short distance, as a straight line. Such a recording is found very useful when a true picture of the surface is required.

Very strong feelings have been expressed for and against the E system. Mr. R. E. Reason (England) claims that it cannot be embodied in present-day instruments, since the sphere of the measuring instrument cannot touch the surface at the same point and at the same time as the

Fig. 1 Geometrical definitions of surface roughness: (top) the mean or centre line, and (bottom) the envelope line.

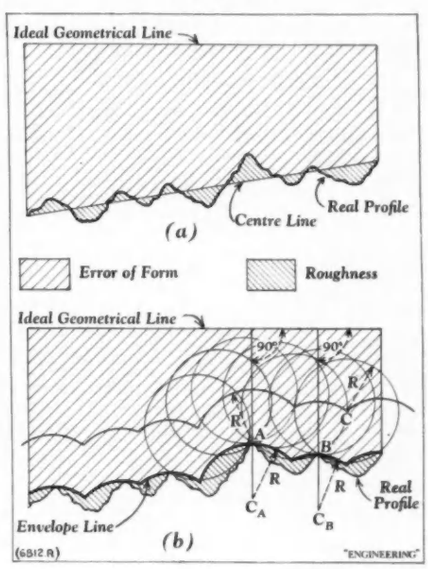
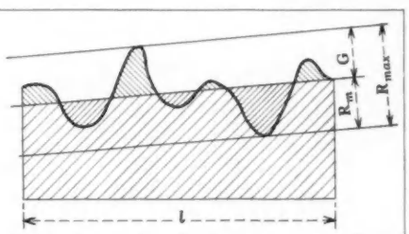
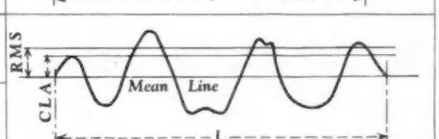
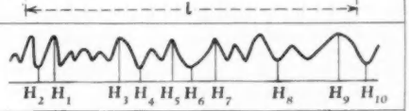
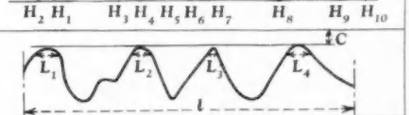
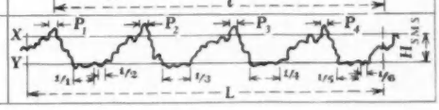


Fig. 2 Eight standards for measuring surface roughness, showing the countries in which each is used. For countries which use more than one standard, the one chiefly used is indicated by underlining the country's name.

Standard	Formula	Used In	
Maximal Depth	$R_{max} = (y_{max} - y_{min})$	Germany Austria Switzerland Italy Sweden Jugoslavia Poland Czechoslovakia Russia Belgium	
Mean Depth	$R_m = \frac{1}{2}\int_0^l y\,dx$	Germany Austria	
Depth of Smoothness	$R_p = G = R_{max} - R_m$ G stands for Glattungstiefe (German)	France Germany Switzerland	
Arithmetical Average	$CLA = \frac{1}{2}\int_0^l \lvert y \quad R_m \rvert\,dx$	Gt. Britain USA Holland Spain France	
Geometrical Average (Officially Abandoned by USA, but Still Used)	$RMS = \sqrt{\frac{1}{2}\int_0^l (y - R_m)^2\,dx}$	USA Russia Poland Czechoslovakia	
Peak to Valley Average (Although Recommended by BS 1134, Very Rarely Used)	$PVA = \frac{(H_1 + H_3 + \cdots H_9) - (H_2 + H_4 + \cdots H_{10})}{5}$	Britain	
Percentage Bearing Area	$B_A = \frac{L_1 + L_2 + L_3 + L_4}{l}\,100\%$	Germany Switzerland Austria	
Swedish Standard (6812 s)	$H_{SMS} = (X - Y)$ Lines X and Y Positioned so that $\Sigma P = k_1 L$ $\Sigma V = k_2 L$ Swedish Standard Appoints $k_1 = 0{\cdot}05$ $k_2 = 0{\cdot}10$	Sweden	

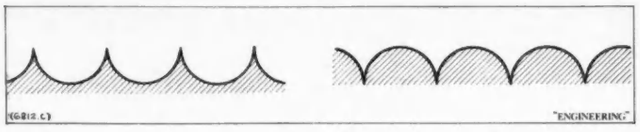


Fig. 3 (above) Two obviously different surfaces which give the same CLA reading.

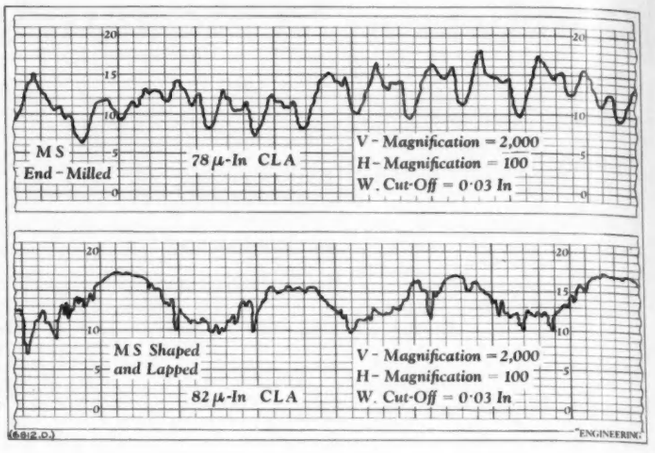


Fig. 4 (right) Profile graphs of two surfaces (a top and b bottom) which give the same CLA values but which feel different.

stylus. The countering argument, that the stylus instruments based on the M system operate by means of a skid travelling along the E line, and thus tend to meet the requirements of the E system, is less convincing since these instruments integrate the numerical values based on the centre line, and therefore the relative position of the stylus to the skid is of lesser importance. Another point against the E system is that stylus instruments operate in the field of two dimensional geometry and therefore the sphere creating the E line should be reduced theoretically to a two-dimensional disc, and for practical purposes the thickness of the disc should not be larger than the radius of the stylus tip. This limitation cannot easily be embodied into an instrument since it would have a thickness of from 0·0001 in to 0·0005 in. If the sphere is used instead of a disc, and the peaks immediately on either side of the line being explored are larger than the highest peaks along the line, errors will be introduced.

METHODS COMPARED

Von Weingraber (Germany) and Bickel (Switzerland) are of the opinion that the M system is inadequate in many respects, but mainly because of the great difficulties in determining the actual position of the M line, since it requires at least six planimetric evaluations. This is impracticable, and generally, direction and position are only assessed. The M system is therefore condemned as being inaccurate and unscientific. Although this criticism is factually correct, it is in the writer's opinion unrealistic since the whole field of surface roughness evaluation is far from being an exact science as yet. The adoption of the E line would bring little advantage to the practical engineer, and there are many other problems to be solved, mainly of a functional nature, which are more important in surface roughness control. This, however, does not mean a condemnation of the E system. There is no doubt that it offers many advantages, of which the most important is the clear and unambiguous separation of roughness, waviness and error of form, which the M system does not provide, as can clearly be seen from Fig. 1 where, in (*a*), illustrating the M system, the error of form includes a part of the roughness and waviness, which is not the case with the E system. Before adopting the E system, however, considerable research work has to be done with regard to the most typological information obtainable from the existing standards.

There are, at present, eight national standards as listed in Fig. 2. For countries which use more than one standard, the one predominantly used is indicated by underlining the appropriate name. (There are a few more systems which only express relationships between the quoted standards.)

There is no doubt that none of these gives a complete answer to all the problems involved in surface roughness evaluation, and at present it is difficult to say which of them provides the greatest information about the functional qualities of the surface. It is, therefore, becoming increasingly obvious to many engineers who take the surface roughness problem seriously that instruments are necessary to measure more than one standard to fulfil every surface requirement of precision engineering.

In Britain, and lately also in the USA, the CLA (Centre Line Average) method, which is described in BS1134:1950, is defined as "the average value of the departure of the profile from its centre line, whether above or below it throughout the prescribed sampling length." This is the arithmetical average, which has no mathematical relationship to the total depth, and as will be shown later varies from about a quarter to one-twelfth of the actual depth.

The CLA method has great advantages: its instrumentation is easy, the dispersion or scatter is relatively small (only 10 per cent to 30 per cent) and in most cases CLA readings agree with the results obtained by tactile comparison and consequently with our natural concept of roughness. There are, however, some cases, and unfortunately they are not rare enough to be ignored, where the CLA method fails completely.

Fig. 3 shows a well-known example of two surfaces, which measured with a CLA reading instrument give the same value, and since CLA is supposed to give a quantitative designation to the surface quality, we are asked to believe that both surfaces are of the same quality. The argument that this is an extreme case which exists only in theory and does not represent any known machining process is fallacious. While admittedly the diagram illustrates an extreme case unlikely to occur in practice, there exist many actual surfaces closely approximated to the ones shown. Surfaces produced by any machining process, which are afterwards finished by another process, whether it be lapping, honing or papering, often produce characteristics closely resembling Fig. 3.

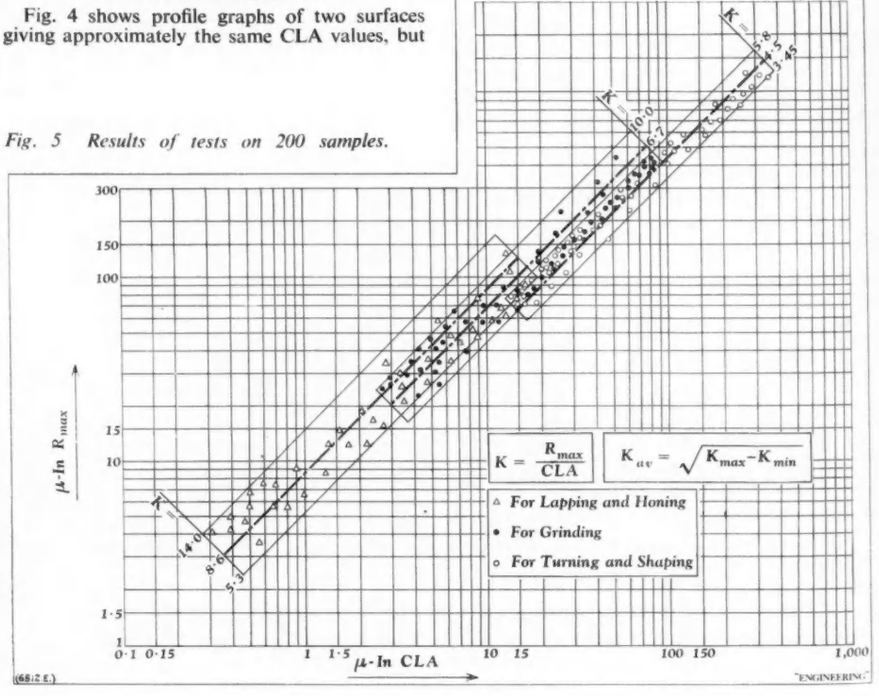
DECEPTIVE READING

Fig. 4 shows profile graphs of two surfaces giving approximately the same CLA values, but when the finger-nail is run across the surfaces we certainly find that (*a*) is much rougher than (*b*). Also when looking at the graph our common sense tells us that the finger-nail is telling us the truth and that the CLA reading instrument is deceiving us. In fact the functional qualities of the two surfaces are very different. The load-bearing area and depth of smoothness of (*a*) are only a fraction of those of (*b*), and the effect of frictional wear on (*a*) will be quite different from that on (*b*).

(*a*) represents an end milled surface of 78 micro-inches CLA while (*b*) is a shaped surface, but the peaks have been lapped down giving a reading of 82 micro-inches. Although (*b*) can be called a freak surface, it is not an unrealistic one. A second operation has been superimposed on the first, which is common practice in engineering. Very often, ground surfaces in particular are finished by lapping or honing, either to remove a small amount of stock, reduce the error or form or improve the surface finish, by which the original machining marks are only partly removed. On all these surfaces the CLA readings do not represent the true surface quality.

The latest developments in engineering demand a clear and unambiguous quantitative assessment

Fig. 5 Results of tests on 200 samples.



Production

of the surface quality, where it is important for a particular function or performance. This essential surface quality is not the same for every component, and not even for every surface on the same component. While for some surfaces the average height of irregularities (CLA) is that only important factor, in others the percentage bearing area or the depth of smoothness (G) is the criterion; in this case CLA or maximal is meaningless. On a third surface, the finish may be of importance only with regard to resistance to fatigue; in this case it is only maximal depth that matters.

While the controversy still rages, it is useful to have some idea of the relationship which connects the two main competing systems, namely CLA and maximal depth, R max. There is no general mathematical relationship between the two, although $\frac{R_{max.}}{C\,L\,A}$ equals π for sinusoidal profiles and 4 for square waves, though these never occur in practice.

where $\log C' = C$.

Whence $$K = \frac{y}{x} = C'\,x^{-\epsilon}$$

or, taking logs

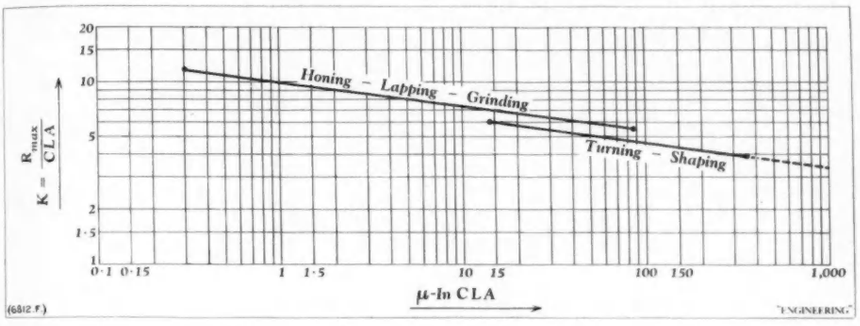
$$\log K = \log y - \log x = C - \log x.$$

This shows that a graph of K plotted against x on logarithmic paper will be a straight line of slope $-\epsilon$, which, within the limits of accuracy of the measurements, appears to be the same for all types of finishes, namely, 0·15. Straight lines thus obtained are shown in Fig. 6.

It is interesting to note that the lines for lapping and honing and for grinding coalesce, while the line for turning and shaping is separate and lower down the graph.

Unfortunately, there were not enough test samples available above 350 micro-inches C L A, but four between 400 and 1,000 micro-inches showed that the straight line could be continued. It will most probably be accurate enough up to 1,000 micro-inches, when $K = 3{\cdot}5$. The line for honing and lapping and for grinding, however, cannot be continued above 90 micro-inches C L A because above this value results were found to be erratic, giving the errors for K in excess of 40 per cent.

Fig. 6 Values of K plotted against CLA value for different surface finishing processes.



TESTS ON SAMPLES

Two hundred samples with different finishes were measured for C L A and $R_{max.}$ on a Perth-o-meter surface roughness instrument, which can be switched from one scale to the other while using the same tracer system; so that for each sample the same profile was measured for both scales. The results of these tests are plotted on the graph, Fig. 5, where $y = R_{max.}$ and $x = C\,L\,A$.

The points on the graph appear to lie around straight lines sloping at 45°, implying a linear relationship of the form $y = K\,x$. The set of points for each finish has been enclosed between parallel lines, with a third line midway between each pair indicating the geometrical average, $K_{av} = \sqrt{K_{max.} \times K_{min.}}$. The value of K_{av} for these lines of geometrical average for each finish was found to be:

8·6 for lapping and honing,
6·7 for grinding, and
4·5 for turning and shaping.

The results above are useful as a first approximation, but closer inspection tells us that a line of slope of rather less than 45°, say $\tan^{-1}(1 - \epsilon)$ would give a more accurate result, this is because the distribution of points around the average line is not uniform. It can be seen, for lapping and honing between 1 and 15 micro-inches C L A, the lower half of the envelope holds three times as many points as the upper half, while between 0·3 and 1 micro-inch C L A the distribution is reversed: the majority of points being in the upper half. The same proportions applied to the two other finishes. This revelation necessitates the modification of the original equation into the following form:

$$\log y = C + (1 - \epsilon)\log x,$$

where C is a constant. Taking antilogs

$$y = C'\,x^{1-\epsilon}$$

The graph Fig. 6 then gives $R_{max.}$ for any C L A value between 0·3 and 350 micro-inches within an accuracy of $\pm$ 40 per cent in nearly all cases, a quite workable limit in the field of surface evaluation (see BS 1134: 1950).

Since the values of $\frac{R_{max.}}{C\,L\,A}$ found in practical engineering range between 3·5 and 14, it is hopeless to choose an average value. The practice of some firms, therefore, of marketing surface roughness measuring instruments reading C L A and $R_{max.}$ on the same scale, without computing each value separately, is highly regrettable. One very well known firm, for example, markets an instrument claiming an average value of K to be 3·7, which is satisfactory for turned finishes above 125 micro-inches, but absolutely useless for finer work.

Engineers having dealings on the Continent, where $R_{max.}$ is the predominant standard, with few exceptions, will find Fig. 6 very helpful, and where more accurate information is required, they will see that an instrument reading $R_{max.}$ and C L A separately is called for.

BIBLIOGRAPHY

The Measurement of Surface Texture, by R. E. Reason.

Messung der Oberflächengüte, by G. Schlesinger.

Prüfen und Messen der Oberflächengestalt, by Johannes Perthen.

Surface Roughness Waviness and Lay, published by the American Society of Mechanical Engineers, New York.

Moderne Probleme der Oberflächenprufüng, by Dr. H. Schorsch.

Zur Definition der Oberflächenrauheit, by H. v. Weingraber.

Report on the Meeting of Working Group R (Roughness) of the CIRP, Vienna, 1958, by E. Bickel and H. v. Weingraber.

A Guide to the Assessment of Surface Texture, published by HMSO.

Marketing

Bashful Germans?

The success symbol of the German industrialist or banker may soon be that peak of luxury—a Rolls-Royce. At the Frankfurt motor show Rolls started a drive to sell their cars to the West Germans, who have so far not gone in for Silver Clouds and Phantoms in the degree the makers would have liked.

The target is to sell between 1,500 and 2,000 limousines which would still not give West Germany double the number of Rolls and Bentleys owned in much smaller Switzerland, where there are more than a thousand prosperous motorists using either a Rolls or a Bentley.

One possible explanation has been suggested for the lack of Rolls consciousness among the Germans. It is that while there is sufficient money about, potential customers will not attract the attentions of the income tax man by so obvious a display of purchasing power.

Since it is not to be imagined that the German tax inspector is more determined than his British brother, it appears, if there is anything in the explanation, that here is the one field where the German businessman admits to less ingenuity than the British.

Including import duty, a new Phantom V costs a trifle under £8,000 in West Germany.

Back Door to Sterling Trade

More and more United States firms have realised that the only effective way to secure a foothold in British and other Sterling markets is to manufacture in Britain. Many of these have followed the easier solution of licensing their products for manufacture and marketing by a British firm. One of the latest import licensing agreements to be concluded, which is also a good example of the new approach to this problem, is between British Insulated Callender's Cables Limited and the Burndy Corporation of Norwalk, Connecticut.

BICC and Burndy have formed a jointly owned company, with an authorised capital of £250,000, to manufacture and market the existing range of Burndy products here and in the Commonwealth. The new company, BICC-Burndy Limited, will supply all types of electrical connectors to electricity authorities for transmission, distribution and power station work, and to manufacturers of switchgear, household electrical appliances, aircraft, shipbuilding and other industries.

This association between the leading cable makers in the Sterling area and one of the leading American firms in the solderless connectors and terminations in the US will provoke strong competition here for the leading existing suppliers, AM-P (Great Britain) Limited.

Selling in Canada

The successful marketing in Canada of a specialised engineering product such as control instruments requires a type of sales and service organisation able to do much more than merely selling and distributing. In the instrument industry the companies which have made the quickest progress have been those who have equipped themselves to provide users not only with the product, that is, components of control systems, but with the design and engineering of the system itself and with prompt and efficient after-sales service. This is so in North America to an even greater degree than in this country and is no doubt the main consideration which lies behind the decision of Evershed and Vignoles Limited to set up a new company in Canada.

The new company, to be known as Evershed-Powertronic Limited, will operate from Toronto and provide a complete coast to coast coverage.

This represents a major expansion of the parent company's activities in Canada, where they have made much headway recently with their automatic electronic equipment. The new arrangement will not affect the marketing of Evershed and Vignoles' electrical testing instruments, which will continue to be handled in Canada by R. H. Nichols Limited, who have sole rights.

Drills for Tito

Evidence of a change in the method of trading of the Yugoslav authorities was reported recently by Woodfield Hoist, of Rochester (Kent), the manufacturers of oil drilling rigs and allied equipment. The company were recently awarded a large contract in the face of competition from German, Italian and American companies. The contract is for the manufacture and supply of a number of rigs capable of drilling to depths of 8,500 ft, worth over £750,000.

News that such a contract was being offered was given by Woodfields's agent, Standard Representative Engineers of Belgrade. Yugoslavia allows a small number of private agencies of this type to function in order to keep the appropriate authorities in touch with the latest technical developments in the plant and equipment the country requires " in the interests of the State Plan."

Trans-Europe Trailers

Considerable efforts are being made both by rail and road transport to increase their freight business. The accent is currently on a door to door service, using containers—in this case boxed semi-trailers—in which the manufactured goods are packed for delivery without unpacking of any kind to the manufacturers' customer. Such a service has recently been introduced for Continental freight by European Transits Limited, whose slogan is " anywhere in Britain to anywhere in Europe."

European Transits claim that the main advantages for their service are " the elimination of intermediate handling and delivery delay and the reduction to an absolute minimum of expensive packaging," and that their method is well suited for the movement of machinery demanding a fast reliable method of transport. Goods are carried in boxed semi-trailers, fitted with retractable roof, together with automatic adjustable lashings which ensure stability in transit.

Convair for Swissair

Freight-passenger aircraft are beginning to gain in popularity with the freight-conscious airlines. Two of the leaders in this class, Swissair and Scandinavian Airlines System, acting jointly, have placed an order for seven Convair 600 jet transports. These aircraft, which will be known as " Coronado," will be operated over long hauls by Swissair and SAS. The order for the Convair 600 replaces an earlier order for five intercontinental Convair 880's. The reason for the change is that the Convair 600 meets the needs of the two operators better than the 880, due to its 10 ft longer fuselage section, enabling it to accommodate larger pay loads, and its considerably greater fuel load capacity. Swissair will lease two Coronados to SAS for four years.

At Home

COSTLY WARMTH

It is sad that the only free source of heat in the world should be such a variable factor in this country. The chances of a house heated by concentrating the suns rays may be good in favoured spots (although where the sun is brightest, it is cooling and not heating that is required) but here in England it is doubtful if the solar house now being developed in America will ever be really practicable. It does sound attractive though, to have all the heat and power you want just by putting a reflector on the roof.

Still, here, heat has to be paid for whether it comes from coal or oil, by way of gas or electricity. Therefore it seems all the more a pity that so much costly heat should be wasted in warming the atmosphere. It does not make much difference to that. All this preamble of course leads up to a plea that more attention should be paid to proper insulation of houses and buildings—houses in particular since it is there that the ordinary person can benefit most.

Most area Electricity Boards have cheap rate schemes for using power during off-peak hours. Such power can be absorbed in storage heaters (there are many on the market) and recovered during the day. Gas Boards too have special heating tariffs. But though these are economical ways of buying heat they do not in any way compensate for the enormous amounts of heat that escape through the walls, windows and roof of the house.

Much can be done to prevent the loss of heat both in new building work and in existing houses. The effectiveness of the cavity wall can be increased by the addition of a lining either inside the building or in the cavity itself. The Thermagrade system developed by EAW Industries is an example. In this arrangement plastics sheets are hung from specially shaped ties, the lower edge of one sheet keying with the upper edge of the next. Plain sheet is used for insulated cavity walls and ribbed sheet as an undercloak for tiling and in cross walls. The sheeting is moisture proof as well as thermally insulating, and there is an angular section available to give perimeter insulation to the floor—of particular advantage where under-floor heating is employed. The material is unplasticised pvc and does not support combustion. It is claimed to be almost untearable.

Jablite is a material that can be used for lining walls, roofs or ceilings. It is made of expanded polystyrene and is extremely light. The weight of the standard grade is about 1 lb per cu. ft and it contains 98 per cent of air. Being a polystyrene it will burn, but it is said not to contribute to the fire risk of the building. Where fire risk is significant, there is a special NonFlam grade that is self-extinguishing and carries a Class I Spread of Flame equivalence rating.

Fixing is a very simple process, the cut sheets being merely stuck in place with an adhesive. It is worth noting that some organic solvents used in adhesives will attack the material, so it is recommended that the type developed by the makers should be used. Jablite has a natural white matt finish but colours can be incorporated during manufacture. Sheets are also available with special finishes such as asbestos, vitreous enamelled steel, chipboard, glass and roofing felt. The natural surface can also be painted. The sheet material can well be used as an underlay for under-floor heating to prevent the loss of heat downwards to the earth. As well as being thermally insulating, the material is damproof and gives good noise insulation. Moulded shapes can be obtained to fit such items as water tanks.

A fire proof insulating board is Asbestolux. This does not use cement as the bonding medium but is made from asbestos fibre bonded by high pressure steam with silica. It is therefore not brittle and can be nailed in place without fear of splitting. The makers claim that it is fire proof, rot proof, mould proof, insect proof, and vermin proof. Its main use is as a liner for walls and ceilings, or for partition walls in shops and buildings, and it has the advantage that it is not affected by steam so it can be used in bathrooms and the like. It is available in various sizes of sheet and can be cut with a saw, drilled or nailed. Under official test it has given four hours fire protection to structural steel work.

Another lining material is Treetex, an insulation board made from soft wood fibre and given a profiled surface to enhance the finish. The profile is a shallow one of crests and hollows which does not weaken the sheet. The pattern is so chosen that the long edges of sheets may be joined to give an uninterrupted design. It can be fixed by panel pins, staples or adhesive to wood or concrete.

A material that uses a rather different principle is Foylin. This consists of insulation board to which a layer of aluminium foil has been fixed on one or both sides. Thus to the natural insulation of the base material is added the reflective properties of the aluminium for both light and heat. Moreover the aluminium surface can be washed down with disinfectant without damage. As a roof insulation it is recommended that the Foylin boards should be placed on the rafters with the foil uppermost and the edges sealed with tape. Battening for tiles can be laid on top.

The loss of heat through windows was the subject of At Home for 9 October when two types of prefabricated double-glazed units were described. Double glazing is undoubtedly the remedy for this trouble and can give quite spectacular results.

Double glazing can of course be applied to existing houses. A very simple method has been developed by Dohm Limited. In this the inner glazing sheet is made of transparent flexible plastics material with a fabric binding along the edges in which are fixed press studs. The binding is backed by a foam rubber strip. The press studs clip over screws inserted round the window frame and providing the seal is good the heat losses should be much reduced.

Probably one of the easiest ways to insulate the roof space in older houses is to lay a mat of glass fibre or insulating felt on the joists. Alternatively a layer of foil can be nailed to the rafters to box in the loft. A test of whether the roof is properly insulated can be made when snow has fallen; if the snow lies, then things are alright and the roof is insulated. But if your snow melts before next door's, then you know that a lot of the heat you bought so dearly is doing you no good at all.

ENGINEERING

Published every Friday by ENGINEERING LTD. at 36 Bedford Street, London, WC2.
Telephone: Temple Bar 3663.
Telegrams: Engineering Lesquare London.

CHAIRMAN: J. A. Dixon, M.A., A.M.I.Mech.E.
EDITOR: F. B. Roberts, M.B.E., M.I.Mech.E.
DEPUTY EDITORS: D. Fisher, Ph.D., B.Sc., A.M.I.C.E., A.M.I.Mech.E.
E. P. Ward, M.A., A.M.I.Mech.E.
ASSISTANT EDITORS:
Design: W. L. Morse, B.Sc. (Eng.) A.M.I.Mech.E., A.F.R.Ae.S., A.F.I.A.S.
Metals and Materials: D. C. E. Gribble, B.Sc.
New Plant and Equipment: A. A. H. Scott, B.Sc., A.M.I.Mech.E.
Parliament and Institutions: J. E. Dodsworth.
Research and Development: R. A. Coffee, D.I.C., A.M.Brit.I.R.E.
MIDLANDS CORRESPONDENT: W. K. V. Gale.
EDITORIAL DESIGNER: J. T. Godfrey.
SUBSCRIPTION MANAGER: G. A. Roberts.
ADVERTISEMENT MANAGER: G. H. Dixon.
Annual subscription rates: Inland and abfoad £5 10*s* (Canada, £5 5*s*). Three months 27*s* 6*d* all countries. Single copies, 2*s* 7*d* post free.

ENGINEERING INFORMATION SERVICE:
Assistance is available from Engineering Information Service in obtaining information, and in locating sources of information, both technical and commercial. EIS deals, for example, with names of makers and suppliers of plant and equipment, technical data on design, markets for engineering products and the compilation of references to information on specific topics. Inquiries should be addressed to Engineering Information Service, 36 Bedford Street, London, WC2.